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BORN AUGUST 31, 1880. SUCCEEDED TO THE THRONE NOVEMBER 23, 1890. CROWNED SEPTEMBER 6, 1898.

WILHELMINA HELENA PAULINE MARIA, QUEEN OF THE NETHERLANDS.

From a photograph by Kameke, Royal Court Photographer, The Hague.

WILHELMINA, QUEEN OF THE NETHERLANDS.

IN the last few years two monarchies of Europe have been ruled over by a boy king and a girl queen, the government, during their minority, being in the hands of a Queen Regent. We refer to King Alfonso XIII. and Queen Wilhelmina. Of the two child monarchs, relatively little has been heard of Wilhelmina, but she has now attained her majority, and has taken her place among the crowned heads of Europe. Particular interest is attached to the new Queen of the Netherlands, in view of the fact that she is the last of the house of Orange, a house famous for hundreds of years on account of the great military achievements of several distinguished leaders. The young Queen has always had a place in the hearts of the people of Holland, and she has always been referred to as "our little Queen." It is a curious coincidence that, after three centuries have elapsed, the thrones of the Netherlands and Spain should both be held by children. Both are lineal descendants of those arch enemies Philip II. and William the Silent, the former the destroyer of Dutch civil and religious liberty, the latter the founder and maintainer of it.

There is little wonder that the birth of Wilhelmina Helena Pauline Maria, on August 31, 1880, was warmly welcomed by the nation. Her father was King William III. and her mother was a daughter of the Prince of Waldeck-Pyrmont. The death of the sons of the king left Wilhelmina the sole heir to the throne. As Regent of the kingdom during her daughter's minority, the Queen Mother has had comparatively little leisure since the late king's death. In the scrupulous attention to the duties connected with the administration of state affairs, she has given an example of unflagging industry. She has been equally faithful in her maternal duties, and found time continually to assist at her daughter's lessons and to enter into her pleasures. The little Queen was of the most delicate constitution during her early years, and grave doubts were at one time entertained whether she would ever reach womanhood, but, under the careful tutelage of her wise mother, she has developed into a healthy woman.

The coronation ceremonies took place at Amsterdam on September 7. The ceremonies themselves were simple, the surroundings were most impressive. Like the Czar of Russia, the sovereign of the Netherlands is not crowned, but personally assumes the royal diadem and constitutes himself or herself in the seat of power. The formalities of the occasion, though not difficult to perform, could not fail to be a trying ordeal to the young Queen, but she acquitted herself in a manner thoroughly befitting a descendant of the house of Orange, and her gentle dignity was in accord with the splendid traditions of the Dutch nation. The Queen of the Netherland is her proper royal title, for Holland, though containing the chief cities, is but half a small country, which only in the few years of the French king Louis Bonaparte's reign was ever officially styled the "Kingdom of Holland."

A distinguished company of perhaps about 4,000 men and women were in the New Church at Amsterdam. The Queen was enthroned in a building which is called "new," though it is more than 400 years old and has been partly burned twice. The representatives of Dutch aristocracy, political authorities, foreign ministers, and delegates from other royal houses were present. A large dais was erected in the nave, and above it was a great crimson and gold canopy suspended from a crown. In the center of the dais was a throne, which was a crimson chair with a gold crown. Flowers were wisely omitted, in order not to burden the heavy air. The church was filled by ten o'clock, save the space reserved for the royal party and the officials. It was a brilliant scene, with the brilliant dresses of the ladies and the dazzling uniforms of the men. At 10:45 the trumpeter sounded the arrival of Queen Emma and her suite. The organ played a grand march as the procession proceeded up the main aisle. The Queen Regent was brought from the palace in a carriage drawn by eight horses and escorted by a squadron of cavalry. At eleven o'clock salvos of artillery and the clanging of bells from church towers was the signal that Wilhelmina had left the palace and was on her way to the church. Arriving at the church door, Her Majesty was received by a select committee of the States-General, who were to conduct the only living representative of the house of Nassau legally capable of inheriting the sovereignty. The band played the prelude to the old hymn of "Wilhelmus van Nassauwen" and the choir sang three verses of the anthem. The vast audience rose and the Queen passed into the church, followed by the royal standards, her white gown almost hidden beneath a magnificent dark crimson coronation robe lined with ermine. All bowed low before her, including the Queen Mother. Before the choir had finished singing, the Queen seated herself. Immediately in front of the throne was a table bearing the official crown, the scepter, the orb, and the constitution, but none of these were used in the ceremony which followed. The music having ceased, the Queen rose and read her address in a remarkably clear voice, which could be heard all over the church.

At the conclusion of her address the Queen pronounced the oath, raising her hand at the last words. After the pronouncement of the oath there was a moment's hush, then the great assembly broke into cheers, crying thrice "Long live the Queen!" Then followed the formal declaration of the enthronement prescribed by the constitution. Oaths of the Regents were taken individually by all the officers and all of the members of the national legislature. The whole ceremony was, in fact, technically a session of the legislature in which the Queen was installed, and was entirely devoid of religious formalities. The emblems of authority on the table in front of the throne were tendered to Her Majesty, who bowed in response. Then came the proclamation by the King of Arms, "Her Majesty Queen Wilhelmina is solemnly inaugurated." Then three times he cried "Long live the Queen!" and a great shout was raised which was taken up outside the church and rang through the streets of Amsterdam. The heralds with their trumpeters then left the church and went through the same ceremony outside. One hundred and one guns were fired to inform the Queen's subjects that the ceremonies of her installation were ended. The Queen and the Queen's mother then returned to the palace. Scarcely an hour was occupied by the ceremony, which may well stand as a model of simplicity, dignity, and solemnity. The impressiveness came solely from the personality of the young woman who was its central figure. For our engraving we are indebted to London Graphic.

WORLD'S SAVINGS BANKS.

THE savings bank, in the sense in which it is known at the present day, is strictly a modern institution whose history belongs almost exclusively to the nineteenth century. Wherever English is spoken banks for savings are known as savings banks, but in other languages they are more correctly designated. The Germans have their Sparkassen, the French their caisses d'espargne, and the Italians their casse di risparmio. Four countries each claim the honor of having originated these institutions. It is said that a savings bank was established at Hamburg in 1780 and had considerable deposits, which, when Napoleon invaded Germany, were confiscated. Italy's claim rests on the supposition that the monti di pieta of the fifteenth and sixteenth centuries were banks rather than pawnshops. In Switzerland a sort of savings institution was founded in the cities of Bern, Basle, and Geneva between 1787 and 1794, and in England two savings banks, started for the benefit of women and children, were in existence before the close of the eighteenth century. It cannot be said, however, that any of these institutions occupied a place as a regularly established and recognized savings bank.

It was not until 1803 that a system of country banks was advocated in England by William Malthus to facilitate the saving of small sums and to encourage thrift among the poor. One bank was established in the town of Wendover, where it existed for several years. In 1807 Samuel Whitbread in Parliament proposed a national savings bank under the direction of government officers, the deposits in which were to be invested in government securities and the repayments to be made by the sale of the securities when required. This scheme, like others of a similar character, was not wholly successful, but it gave impetus to savings institutions all over England, and resulted finally, although a half century late, in the establishment of the Post Office Savings Bank, which in the course of thirty-six years has received from depositors (including interest) more than $2,218,600,000, and held on December 31, 1897, deposits amounting to £108,098,640 (about $540,475,000). It has conducted 237,915,710 separate transactions with its depositors, which now number 6,862,034.

The first two savings banks in America were the Provident Institution for Savings, in Boston, which was incorporated on December 12, 1816, and commenced business in the latter part of January the following year, and the Philadelphia Savings Fund Society, which was organized on November 27, 1816, and began business on December 2 of that year, but was not incorporated until February 25, 1819, two years and a half after it commenced business. In the case of these two banks, one commenced operations before it was incorporated and the other was incorporated before it received a deposit. Both are still in existence, but, in view of the facts, it is difficult to determine which of the two is entitled to the greater distinction. The third savings bank in the United States was opened at Salem, Mass., in 1818. At the close of the year 1828 the total deposits of all three banks were about $43,000.

In its growth the savings bank movement has been more marked and rapid in this country than in any other part of the world. In 1897 the total number of savings banks in the United States was 980 and the number of depositors 5,201,132, having to their credit no less than $1,989,376,035, or an average of $372.88, being an average per capita in the United States of about $26.56. The extent and growth of these institutions can be more readily understood by the following figures:

	Number of Banks.	Depositors.	Deposits.	Average.
1820.....	10	8,085	$1,138,576	$131.86
1835.....	52	60,058	10,653,726	176.72
1847.....	76	187,739	31,697,479	168.46
1857.....	331	490,498	98,512,968	200.87
1867.....	571	1,188,309	337,009,452	283.63
1877.....	675	2,395,314	806,218,306	301.63
1887.....	664	3,418,013	1,235,247,371	361.39
1897.....	980	5,201,132	1,989,376,035	372.88

The deposits in the 131 savings banks in the State of New York at the close of 1897 were $766,684,916, or considerably more than one-third of the entire savings deposits of the whole United States. The number of depositors in these 131 banks was 1,805,280, representing 27¾ per cent. of the entire population of the State, the average account being $424.71. In the city of New York—borough of Manhattan—there are 27 savings banks, with deposits aggregating $416,160,584. The Bowery Savings Bank, which is included in this total, is the largest institution of its kind in the United States, and, in fact, in the entire world. Its deposits are just short of $63,000,000, and its total assets are $72,267,920. The depositors numbered on January 1, 1898, 119,263. This, however, is exceeded by the Bank for Savings, which had at the same date 126,051 depositors. Eight savings banks in Greater New York each have over $30,000,000 on deposit.

There are only twenty-eight States of the United States in which savings banks have been established: six of the New England States; five of the Eastern States; seven Southwestern; six Middle; four Pacific States; and the District of Columbia. New York State leads all in the number of depositors and amount of deposits. Then comes Massachusetts with deposits amounting to $453,220,257; then Connecticut, $149,496,556; then California, $129,929,281. The State having the largest average due depositors is California, the amount being $687.09. Rhode Island comes next with $504.48. The smallest number of savings bank depositors is found in the State of Wisconsin, 1,546, and that State has also the smallest total deposits, $200,498. There are more depositors in the savings banks of Vermont (106,169) than in all the savings banks of the Southern States (68,871), and there are more savings bank depositors in the little State of Connecticut (356,445) than in all the savings banks of the Middle States (331,605).

The Post Office savings bank system originated in Great Britain, having been inaugurated on September 16, 1861, by the opening in England of 801 postal savings offices. The following year the system was extended to Scotland and Ireland. At the end of 1863 nearly 180,000 accounts had been opened, the total balances due to depositors being nearly £1,750,000 ($8,740,000). There are now in the United Kingdom no fewer than 11,867 Post Office banks, having 6,862,034 accounts, which had to their credit on January 1, 1897, £108,098,640 14s. 10d., about $540,475,000. The minimum deposit is 1 shilling; the maximum £200 in all. Interest is allowed at the rate of 2½ per cent. Besides these banks there are in Great Britain 261 trustee savings banks, which have 1,500,000 depositors and $219,000,000 on deposit.

These figures speak eloquently of the popularity of the Post Office savings bank and of the place which it has taken in the social economy of the English nation. It has absorbed many trustee banks, but the deposits of the trustee banks now exceed by no less than $30,000,000 the deposits which were in their care in 1861, when the Post Office entered the field as their rival. The Post Office banks have met the wants of a class which the trustee banks could not have reached. They might serve the townsman of fixed abode, but not the people of remote villages or of no settled home. They are the classes whose convenience can be met only by a bank which has its branches everywhere, and which can carry on at any branch a business which it undertook at any other. Fraud, default, and accident have not been altogether absent from the history of the Post Office savings bank; it would be idle to expect that it would escape them, but depositors, of course, have not suffered, and the government, which holds them harmless, has lost but $50,000, or 0·125 per cent, out of the four billions passing by deposit and withdrawal through the thousands of branches of the savings bank.

Other countries which have adopted the Post Office savings bank system are France, Belgium, Sweden, Austria-Hungary, Italy, Canada, Netherlands, India, and Cape Colony, New South Wales, Queensland, Victoria, Western Australia, Tasmania, and New Zealand. The total number of depositors in all the Post Office savings banks of the world in 1896 was 16,345,759, with deposits amounting to $1,016,547,480, being an average deposit of $62.19.

Besides the regular savings banks there are a number of other schemes for savings (carried on by charitable societies and others) and for inducing habits of thrift and economy among wage earners and for the education of children as depositors. The "stamp system" and the penny school savings bank are among the most successful of these outside agencies for accumulating small savings. The stamp system originated in Frankfort, Germany, and has extended rapidly to other countries. It was introduced in the United States by the Citizens' Savings Bank, of Detroit, Mich., in June, 1890, with results that have been astonishing. The city of Frankfort is distinguished among European cities by the large average wealth of its citizens and by its prominence in all that relates to banking and finance. Many of the great banking families had their origin in Frankfort, and there are in that city to-day about 200 banking houses, public and private, many of which are institutions with enormous capital and wide-reaching connections. In such a city it would be expected naturally that the savings bank system would not only include original features, but would embody in a high degree the best results of experienced and competent management.

The Frankfort Savings Bank, which inaugurated the stamp system of savings, was established nearly eighty years ago. It is divided into three divisions: The Savings Deposit Bank, Sparkasse; the Ersparungs Anstalt, a separate bureau under the same management, but differing from it in the fact that it collects from each depositor a stated weekly deposit; and the Penny Savings Institution, whose methods are adapted to the humblest class of depositors. This last department was created in 1882, its object being to reach that class of working people who have no time during working hours to go to a bank with their savings and who, by reason of their scanty and often uncertain incomes, cannot safely bind themselves to deposit a stated sum each week. The bank selected a number of agents in the city, usually grocers, druggists, watchmakers, or other small shopkeepers whose places are kept open day and evening. To these agents are supplied for sale quantities of adhesive stamps, about the size and form of postage stamps, each of which has a value of 10 pfennigs or about 2½ cents. With these stamps is issued gratuitously a small numbered book containing fourteen leaves, each page of which is divided by printed lines into twenty squares of such size that one 10-pfennig stamp may be readily pasted within a square. When the squares on a page are all filled, the sheet represents a value of two marks. Any person desirous of becoming a depositor in the Penny Savings Bank goes to the nearest agent or to the bank, gives his name, address, and occupation, and receives one of these books, each leaf of which has the same number as the cover. The holder of the book then invests his spare pfennigs in savings stamps, which are pasted in the book until one or more pages are filled. The book is then taken to the agent, who removes the leaf and sends it to the Penny Savings Bank, which enters upon its register the number, name, and address of the depositor, and issues in his name and number a deposit account book, which is delivered through the agent to the depositor. As other pages of the pass book are filled with stamps they are detached and sent to the bank, which keeps the account, and at intervals writes it in the deposit book which is sent in for that purpose. Interest is paid on deposits from the first of the succeeding month. The penny stamp savings system has been remarkably successful in Frankfort as well as at all other places where it has been introduced.

The total number of savings banks in the entire world in June, 1897, was 52,200, having deposits aggregating $6,604,546,473, belonging to 45,796,767 depositors, an average of $144.21.

A most remarkable feature in the record of the world's savings banks is the enormous amount of de-

posits in the savings banks of the United States, being 28 per cent. of the aggregate. This is more remarkable when it is considered that over 23 per cent. of the total savings deposits is held in the savings banks of the New England States and New York, New Jersey, Pennsylvania, Delaware and Maryland. Second to the United States in amount of deposits is Prussia. The savings banks of that country hold only about one-half the amount of those in the United States, although they have nearly one-third more depositors. The banks of Austria-Hungary have nearly 5,000,000 depositors, and hold 13·4 per cent. of the total deposits of the world, being exceeded only by the United States and Prussia. France follows Austria-Hungary in volume of deposits (12·6 per cent. of the aggregate), although occupying the first place of all countries in number of depositors — 8,986,631. Second only to France in number of depositors is the United Kingdom, and in amount of deposits it is only slightly behind that country. Including her dependencies, the United Kingdom holds 16 per cent. of the total of the world's savings deposits, but the United Kingdom alone only 12·3 per cent. The savings deposits of the Australasian banks amount to over $130,000,000; the banks of Canada and Newfoundland, about $67,000,000; India over $28,000,000, and other crown colonies over $21,000,000. Next in importance, both in respect of deposits and depositors, is Italy, where the deposits amount to $331,330,100, and the number of depositors to 4,137,908.

In Denmark 45·4 per cent. of the population are savings bank depositors, and it is that country which has the largest average deposit per inhabitant, $75.42. In Switzerland the percentage is 39·6 and the average per capita $59.60. In the United Kingdom the percentage is 20·9 and the average $21.47. In France, 23·6 and $21.84. In Prussia, 19·5 and $29.37. In Austria-Hungary, 12·4 and $20.60. In Italy, 13·3 and $11.01. In the United States, 7·0 and $26.73. The statistics show that the average savings account is largest in Newfoundland, where the amount due each depositor is $440.71. Next comes the United States, $378.31; Canada, $327.97; Austria-Hungary, $180; Denmark, $165.95; Prussia, $150.23; Switzerland, $149.42; United Kingdom, $3.35; France, $92.23; Italy, $80.07. The country having the smallest average due depositors is India, where the amount is but $43.60, and the amount of deposit per inhabitant 0·01 per cent. and the number of depositors to population 0·2 per cent.

FRUIT PRESERVING.

By Mrs. HENRY ESMOND.

STRAWBERRY, RASPBERRY, BLACKBERRY, AND GOOSEBERRY JAMS AND PRESERVES—CHOICE AND PREPARATION OF THE FRUIT.

THIS is the time of the year when the good housewife is busy making preserves and jams. Of course, good preserves, etc., can be bought, but a great saving is effected by making them yourself, and you also have the satisfaction of knowing what is in them. Preserves, pickles, sauces, etc., are not, of course, necessary articles of diet, that is, we could live without them and enjoy good health too; but they are decidedly palatable, and by adding a "smack," as it were, make a good meal better; they also improve the appearance of a table.

Strawberry Jam.—Strawberries and all other berries should not be overripe nor gathered immediately after a fall of rain, as they are then apt to be watery; they should be ripe, perfectly fresh, and sound. Hull the strawberries and, if they are sandy, wash them in cold water; then put them in a colander and let them drain. The strawberries may be left whole or mashed, though it is better to mash them, as they break during the cooking, anyhow.

Always use a granite or porcelain kettle in preference to tin or brass, as the acid in the fruit acts upon the metal and forms a poisonous compound. Measure the strawberries and allow equal parts of fruit and sugar. Do not use cheap sugar, but good fine granulated. Put the strawberries and half the sugar into the kettle, and boil for 5 minutes; then add the remainder of the sugar and boil 30 minutes. Skim often and be very careful that it does not burn. Asbestos mats are very useful in all preserving and pickling; for, when fruit and pickles have to cook any length of time, it is almost impossible to keep them from sticking to the bottom of the kettle. When the jam is done, pour it into large mouthed bottles or glasses which are standing in a shallow pan of hot water. This prevents the jars from breaking. A silver fork or spoon placed in the jar is also a help, as the silver quickly carries off some of the heat. Let the jam cool; then pour 1 tablespoonful of brandy over the top, or cut out some round pieces of white paper to fit over the top of the jam, and dip these in brandy; this is more economical, as 1 tablespoonful of brandy for each jar soon uses up a pint. Cut out some round pieces of paper large enough to entirely cover the top of the jar and come down for an inch or so on the sides; paste these on with flour paste. Keep all preserves, jams, etc., in a dark, warm, dry place; if they are kept in the basement, they are apt to mould. When canned fruit and pickles it does not matter if they are kept in a cold, damp place.

Raspberry, blackberry, and gooseberry jams are made in the same way. When making red raspberry jam, add ¼ pound of red currants to every pound of raspberries; they improve the flavor.

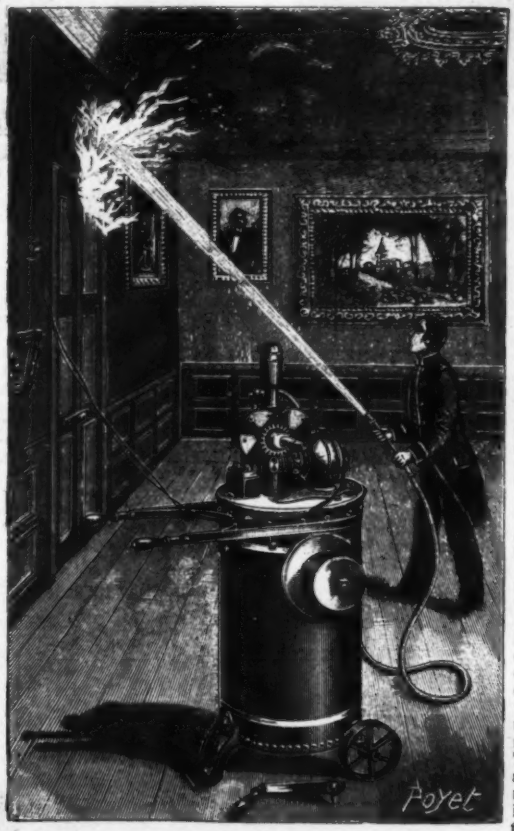
Preserved Strawberries, Raspberries, and Blackberries.—The berries should be ripe, fresh, and sound. If they are sandy, wash them in cold water. Measure them and allow ¾ pound of granulated sugar to every pound of fruit. Into a preserving kettle put first a layer of fruit, then a layer of sugar, and let it stand overnight. In the morning cook slowly until the fruit is soft; 20 minutes will be about the time required. This is one very good way. Another is: Put the sugar and fruit into the kettle in the morning, and let them cook slowly without stirring until the sugar is melted and begins to boil. Then boil briskly for 25 minutes. Skim frequently. Have the jars standing in a shallow pan of hot water to prevent their breaking. Fill them to the brim and screw the tops on immediately. As the contents cool, you will find that the tops can be screwed still tighter. Turn the jars upside down, and leave them this way overnight. If any of the jars are found to have leaked during the night, screw the tops tighter still, and when the jars are put away leave them turned upside down. There is then no danger of the air getting in.

When making red raspberry preserve, use 1 bowl of red currants to every 4 bowls of raspberries; the currants heighten the flavor.—Home Study Magazine.

AN ELECTRIC FIRE EXTINGUISHER.

THE object of the distribution of electric energy through a house is merely to assure the lighting, but it should also lend itself to the most diverse uses, and especially to the running of small motors. We have already made known a large number of such applications, and here is a new one that may prove really useful and render great service. It is a question of a new electric fire extinguisher. The apparatus, which is mounted upon wheels so that it can be readily moved from one place to another, consists of a metallic cylinder of about thirty gallons' capacity. Upon the top of this there is mounted a small electric motor, which, through gearings, actuates a small pump. As soon as the latter is set in operation, it sucks up the water contained in the cylinder and sends it under pressure into a special pipe. It is only necessary for a servant to grasp the nozzle and direct the jet against the flame in order to extinguish an accidental fire.

The setting of the apparatus in operation is very simple. Two electric wires are connected with a collector in order to supply the electric motor, and the pump is immediately started. The quantity of water (thirty gallons) contained in the cylindrical reservoir is sufficient to extinguish an incipient fire; but it is an easy matter, if this quantity is inadequate, to bring a few pails of water to supply the pump.—La Nature.



ELECTRIC FIRE EXTINGUISHER.

WAXEN IMAGES.

WORKS of art in wax suggest collections of imitations of fruit under glass shades which are prepared for the adornment of houses where a fine taste does not prevail. Small figures in wax are occasionally to be seen in museums, and surprise is expressed at the large sums which had to be paid for them. Portraits in wax on a miniature scale are to be found in the Salon and other foreign exhibitions. But in general wax is not a material which finds much favor with amateurs. From its pliability it is supposed to be easy to work, and a high price for an example appears to be an imposition, while the ease with which it melts causes a work for which it has been used to become a source of anxiety. A modern amateur must, therefore, be puzzled when he hears of the extensive use of wax among the ancients. It seems to be incredible that wax was used not only for portraits which were intended for preservation in order to uphold the reputation of a man among his descendants, but also for wills and documents which were to be the titles to estates, so much so that the word cera became another term for page, sheet, or folio, in deeds. The tabulae ceratae had, it is true, a foundation of wood, and precautions were taken to keep the surface from injury, as in the case of diptychs. But the fact remains that the covenants of legal deeds were inscribed on what is to us an evanescent material. When the poet in "Timon of Athens" talks of "a wide sea of wax" for his forthcoming work, we naturally think of praises which are inspired by the necessity of the moment, but to a Greek or Roman the phrase might mean a sort of immortality. They would be satisfied with such fame as could be conferred by the stylus of an able hand on wax.

It was not only in tablets wax was employed. It was an ingredient in paints and served instead of oil. To paint with wax, ceris pingere, signified the production of forms which were more brilliant than was possible with distemper. It is supposed heat was employed to bring out the full effect of the material, but although both Vitruvius and Pliny have left an account of the process, what they say is not sufficient to produce successful results. Another use of wax was to impart a peculiar velvety surface to marble statues, and to diminish the crystalline appearance of the material. In this case also we must suppose there was a dexterity in the application which is beyond the power of a modern sculptor.

The most remarkable use of wax was in the preparation of the ancestral images which were at one time the glory of a Roman house. The satisfaction of a collection of family portraits is as strong as ever among us. Time has condoned the misdeeds of the subjects. Unjust judges, rapacious placemen, stupid generals, or even "bishops who had not left a single sermon," attained some value as evidence of respectability. If portraits are not forthcoming by inheritance, Wardour Street can supply substitutes at reasonable rates. Whether the antique Romans in wax were always authentic representatives of the men whose names were attached to them cannot now be determined. Both Martial and Juvenal had their doubts on the subject, but contemporary writers who claimed to be also guardians of public morals considered the wax figures were not only signs of respectability, but aids to the encouragement of virtue. There is little doubt the practice of preserving images was directly suggested by the honors paid to the Egyptian mummies, but it may also have been a survival of the ancient ancestral worship which is still practiced with fervor by the Chinese. Whatever was their origin, the family in the armaria of the atrium almost rivaled the household gods in their hold on the reverence of a household, and of course the oldest and dingiest examples were held in most esteem. Mrs. Jarley would not be likely, however, to value them at a high rate. For a long time the privilege to possess waxen images of forefathers was restricted to the patricians, and they could only exercise it after serving as consul, ædile, prætor, etc. But when the plebeians became eligible to be seated in the curule chairs, they could no longer be supposed to belong to a race without ancestors. The people appear to have had a voice in the matter, and as they at all times were endowed with far-reaching memories, a patrician's sins were fatal to his own chance of a highly-colored portrait and the distinguishing of his family. That the waxen portraits were sometimes prepared while the subjects were living is evident from the circumstance that one of the consequences of a crime against the state was the destruction of the culprit's image by his family. It was a sort of symbolic refusal to him of the respect of posterity. On some occasions the images were withdrawn from the armaria and carried in procession through the streets by relatives. On such occasions similar robes of office to those which were worn when living were set up on the images. Some archæologists believe that in the processions, instead of draped figures which were carried, portrait masks of the deceased worthies were placed over men's faces just as the tragic or comic masks were worn on the stage, and in that way a more vivid spectacle was secured. There is no improbability in the theory, for "making up" in imitation of particular individuals was practiced among the ancients to an extent that would not be tolerated in a Paris revue.

The Romans were not able to preserve the effigies of their fathers under glass shades with so much success as, unhappily, awaits wax fruits and flowers. As there was a custodian for the armaria in all well-regulated houses, he would, we suppose, be able to patch and color over defects, or, when required, to make reproductions. The atriensis was likely to have some acquaintance with various processes of the arts, for they were so largely employed as adjuncts to luxury, there must have been restorers of various classes who could make themselves useful whenever accidents occurred. The waxen images would not be huddled together in a corner of the atrium; they were too valuable to be neglected like the old portraits which in a modern house are often relegated to an attic. We may assume they were placed like images in Italian churches, and that wreaths and flowers were placed near them, with the inscriptions and eulogies which from time to time were inspired by the man's deeds. They were not objects of worship, but of affectionate respect. Many a Roman gentleman could perhaps say with Sir Lucius O'Trigger, "Though the mansion house and dirty acres have slipped through my fingers, I thank heaven our honor and the family pictures are as fresh as ever."

The state appears to have aided the Roman O'Triggers in preserving ancestral memories in spite of the vicissitudes of fortune. An old house might change hands, but the trophies of the old owners had to be respected. The houses as Pliny says always triumphed over Fate, and became a rebuke to those new proprietors who thought that wealth could take the place of courage and virtue. Whether the images of the former owners had to be taken over with the tokens of foreign conquests and patriotism is not known. But when we learn that Varro published the lives of 700 of the illustrious men of Rome and other countries with their portraits, it is allowable to conclude that, although imagination might be exercised with the faces of foreigners, for the counterfeit presentments of the old Romans there must have been some materials which at least had tradition to give them value. As works of art waxen images are generally without value, and the ancient examples could hardly be of a higher character. But with such a material there is a necessity for more fidelity to nature than is required with portraiture in stone or wood. Varro was too grand a Roman to neglect any means which would insure correct likenesses of the old citizens, and he would not have attempted portraits if they were no more than exercises of the fancy of artists.

What kind of reproductions were employed by Varro must remain a subject for speculation. Winckelmann supposed the copies were reliefs in plaster on a small scale, resembling casts of coins and medals. But that would hardly be a creation which was described as sufficient to excite the envy of the gods. We may, however, conclude they were not full size copies of the figures, busts, or masks in wax, although originals of the kind may have been used from which to make copies.—The London Architect.

OBJECT LESSON ROADS.

The Year Book of the United States Department of Agriculture, edited by Mr. George William Hill, is filled with interesting papers, the work of experts, who give a report of the work carried on by this most important branch of the government.

"Object Lesson Roads," by Gen. Roy Stone, who is the Director of the Office of Road Inquiry, is one of the most important papers in the volume. By the courtesy of the editor of year book, we are enabled to present the illustrations which go with this paper. The following is a brief résumé of the work which has been done.

Fig. 1.—WORKING THE ROAD MACHINE.

Fig. 2.—ROAD BUILDING BY UNITED STATES DEPARTMENT OF AGRICULTURE FOR NEW JERSEY AGRICULTURAL COLLEGE AND EXPERIMENT STATION, NEW BRUNSWICK, N. J.

In many parts of the United States the roads are torn up with the outcoming frost in the spring, soaked with the autumn rains, frozen into ridges in the winter, and buried in dust in the summer, making four regular seasons of bad roads, besides innumerable brief "spells." It is hard for men, accustomed all their lives to country roads under these conditions, to believe they can actually be made good all year around. The lecturer on good roads, therefore, is listened to like one who tells fairy stories or travelers' tales of distant lands, but, put down a piece of well made macadam road as an illustration, and let the people try it in all weathers, and no lecturer is needed. The road speaks for itself; all doubts disappear, and the only question raised is, How fast can it be extended?

Members of the Legislature of Virginia visited the roads of New Jersey in the early spring and found them covered with newly fallen snow, which the farmers removed, so as to show the firm, smooth surface underneath. This demonstration and the fact that wet and snow did not make the macadam road muddy were worth more than any amount of argument, and the Virginians went home to their impassable highways converted to road improvement.

Fully impressed with the importance and value of this object lesson in teaching, States which are making the most definite progress in rebuilding their roads are taking pains to scatter the work in small sections, although in many cases this plan does not secure the greatest direct benefits in the actual use of the roads.

The Road Improvement law in Massachusetts requires the State roads to be fairly apportioned among the different counties. The amount of road to be built in one locality was limited at first to the maximum of two miles. The present road map of the State, therefore, shows roads only as spots apparently scattered over the State, although the intention is, of course, to join them ultimately into systematic lines. This distribution has been made to give the people of the State some knowledge of the value of improved highways, and this knowledge has manifested itself in entirely increased appropriations of State funds for this purpose.

The State-Aid law of New Jersey allowed the application of this contribution to any section of road not less than a mile in length, where the local property holders were ready to contribute 10 per cent. of the total cost. This law has had much the same effect as in Massachusetts.

The State of Connecticut has followed the same plan as that of New York and the State of Rhode Island has limited its construction to half mile samples, one in each of the different towns.

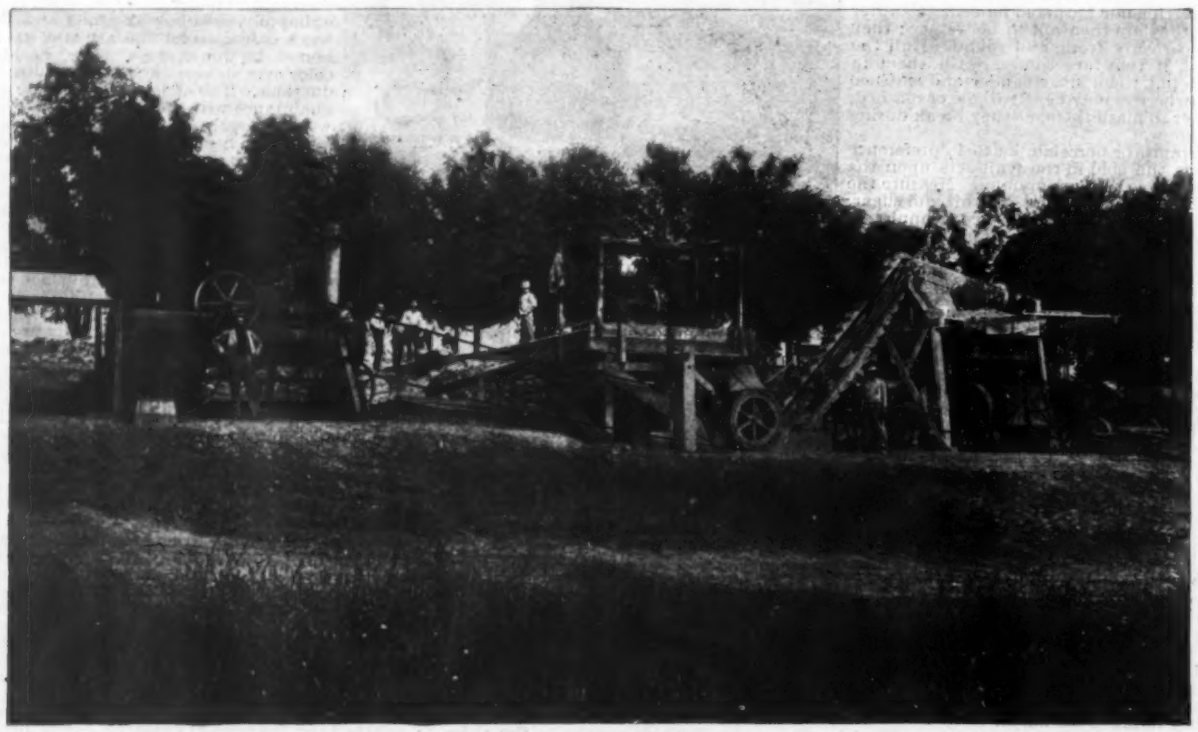
The Office of Road Inquiry recognized the value of the object lesson method of giving instruction by direction, and the Secretary of Agriculture sent a letter to the presidents of all agricultural colleges and directors of experimental stations, outlining what the government would do toward road building, provided local authorities co-operated. No very definite plans were promulgated in this letter, but views and suggestions were asked for. Favorable replies to the letter were received from nearly all of the colleges and experimental stations, making it very evident that the co-operation proposed would be readily secured and promising much for ultimate success.

The Secretary of Agriculture signified his approval of this practical line of work, and arrangements were made to begin operations. As Congress had provided no money for actual road construction, the Road Inquiry Office was obliged to curtail all its other expenditures in order to accomplish even a small amount of the work in this direction.

One of the first sections of the road improved was near the State Experimental Station, formed at New Brunswick, N. J., on what is known as Nichol Avenue. The portion improved is 660 feet long. The roadbed with its general grade was followed and dressed up with an American road machine. The shoulders were made up from the natural soil taken from the side of the road, the soil being red clay, resting on red shale foundation. The stone used was New Jersey trap rock, brought by rail from the Rocky Hill quarries. The stone had to be unloaded from the cars and hauled to the crusher. This extra hauling added to the cost. The distance from the crusher to the road where the stone was used was about one and three-quarters miles. All the stone used was crushed, except a little used to finish the road. The total cost of the stone was $146, that of labor, sprinkling, rolling, and cartage $175. The cost per linear foot was 48⅔ cents; the stone was laid 8 feet wide and 6 inches thick.

Another sample of road was made at Geneva, N. Y. The special agent and the road expert of the Road Inquiry, Mr. E. G. Harrison, visited Geneva, N. Y., with a view of arranging to put in a sample road near the experimental station. He considered that the road would cost from $7,000 to $8,000. Two of the largest real estate owners along the line contributed $1,000 each, and the town of Geneva contributed $3,000, the town board $2,900, and the New York Experimental Station $1,000.

Mr. Harrison attended a citizens' tax meeting and explained the conditions upon which the government would supervise building the sample road. It was significant that the appropriation of $3,000 was carried by a vote of 60 to 4.



ROAD BUILDING BY UNITED STATES DEPARTMENT OF AGRICULTURE AT GENEVA, N. Y., SHOWING CRUSHING PLANT.

The machinery sent to Geneva for this work is shown in our engraving. It consisted of a No. 4 Champion crusher, driven by 20 horse power engine, with elevators, screens, and special receiving pockets, and furnished, without charge, by the Good Roads Machinery Company, Kennet Square, Philadelphia, Pa.; also two special distributing carts, one Champion road machine, such as is shown in our smaller engraving, and one roller and grading plow. A 20-ton steam roller was furnished under the same terms by the Buffalo-Pitts Company, of Buffalo, N. Y. The total value of

the plant furnished was between $6,000 and $7,000. The road was an expensive one, owing in part to the fact that it was a city street, requiring attention to sewers, gas and water pipes, and also requiring grading to a nicety, not necessary in country roads. The grading was also very difficult, owing to the fact that the road had been graveled for many years with very coarse material, including a large amount of cobble stones. Most of the field stone which was used for the foundation was hauled from a distance of several miles, and trap rock surface material was brought over 300 miles from the Palisades on the Hudson River. The length of the new road was one and a quarter miles. The foundation was entirely of crushed field stone, laid 5 inches thick, with a surfacing of trap rock 3 inches thick. During the construction of this road it was visited by many hundreds of farmers from different portions of the State, including officials from half the counties in the State. The disbursements were as follows:

1,214 yards of trap rock	$2,898 31
1,683 yards of field stone	1,668 00
Grading hill	679 44
Teams, men, tools, etc	3,800 57

The new road has met with great favor, and received a large amount of use. At one season of the year it was the only place where horsemen could drive, and anyone who has a load to draw and can go over the road does so. It is interesting to note that the town of Geneva purchased the road machinery.

Other sections of road were constructed at Warren, Pa.; Ilion, N. Y.; Kingston, R. I.; Florence, N. J.; and Englishtown, N. J.

In some cases the government has furnished no financial assistance, as the sections of the road are not near an agricultural college or experimental station, but it has assisted with such advice and encouragement as could be given without cost.

It is the intention of many States, besides Massachusetts, either by connecting their detached sample roads or by laying down long lines to be built as a whole, to establish State roads upon the principal routes of travel which shall be object lessons on a large scale.

The legislators of New York have frequently had under consideration the subject of a network of roads connecting all of the counties and cities by north and south and east and west lines. The same or similar plans have been proposed in Pennsylvania, Maryland, and California. Other States have proposed to limit their object lessons to a single road, running lengthwise of the State, or two lines crossing each other at the capital. Should these plans be put into execution, it will be very important for these roads in the different States to be made to connect all these State lines and thus form inter-State roads. It would greatly increase the value of the inter-State roads and stimulate the general public interest in road building if some of these roads could be connected or combined so as to form, in a measure, a national system, such as was planned and executed by the government in the early days of this century.

The most effective lines that could be adopted for this purpose would be an Atlantic and Pacific coast line, joined by a continental highway extending from Washington to San Francisco. The greater part of the Pacific coast line, 750 miles in length in California, has been mapped out by the highway commission of that State. That portion of the great continental line between St. Louis and Kansas City is already located in the first great State highway of Missouri, the remainder of the total of 5,000 miles of lines naturally connecting the great cities.

Lines of road built by the several States within their own borders, and by the government through its lines and reservations, would be an invaluable lesson, not only as to the direct benefits of road improvement and the methods of accomplishing it, but to this must be added the enhancement in value of the property along its lines. In many States it would doubtless be built on the assessment plan, distributing the cost over many years, but ultimately placing the burden upon adjoining and neighboring property specially benefited. A great national highway, worthy of the name, would tend to enhance the value of property for miles on either side of it, and the benefit obtained would greatly exceed the cost of the road.

A NEW MECHANICAL MOTION.

WE always feel incredulous when a new mechanical motion is introduced to us. There has been so much ingenuity expended on the transmission of power that every possible method seems to have been discovered years ago. Sometimes one has to go back many years to find the original, but it is very seldom that the search is not successful. It is, therefore, with considerable misgiving that we call the device illustrated by the annexed engraving "a new mechanical motion;" however, it certainly is new to us, and we have had a fairly wide acquaintance with such matters. As will be seen, it is a variable speed bevel gear, an elliptical bevel wheel driving a conical wheel, or vice versa. The salient feature, which renders the arrangement possible, is the shape of the pinion. It will be seen that on one side the teeth are carried further toward the intersecting point of the two cones, and that these extended teeth gear with the teeth on the short radius of the elliptical wheel. On the other hand, the short teeth on the pinion gear with the teeth on the long radius of the elliptical wheel. Intermediate between the long and the short teeth are others of graduated length to gear with corresponding teeth on the large wheel. The result of the arrangement is that while the small wheel makes two complete revolutions for each revolution of the large shaft, one of the wheels must run at a variable speed, the two extreme speeds being proportional to the longest and shortest radius of the elliptical wheel.

This very neat and ingenious motion is the invention of Mr. John Favets, of 103 Hatton Garden, who applies it to the driving of bicycles. Driving by bevel wheels is now making a strong bid for favor, especially in America, and it is intended by means of this variable gear to equalize the effort on the pedal over a considerable arc. The crank is applied to the axis of the large wheel; when the crank is descending, and the rider is able to exercise his full power, the large radius of the elliptical wheel is in action. When the crank gets on to the center, the small radius becomes operative. The result is that the crank revolves more quickly when near the center and more slowly when in the best position for the rider to drive it. Hence, the driver can use his muscles for a greater proportion of the

A NEW MECHANICAL MOTION.

period occupied by one rotation of the crank than if he had uniform gear.—Engineering.

MACHINE FOR PROPELLING A BOAT BY MEANS OF PADDLES WITH CONSIDERABLE SPEED AND WITHOUT EMPLOYING MANY MEN.

IT is necessary to place on the sides of your boat the two paddle wheels, A and B, as shown in the figure. Afterward, when you desire to move your boat, you will have the wheels revolved, through their cranks, by two men, or by four at the most. As the paddles succeed one another continually in the water, and make continuous purchases therein, they will cause the boat to move forward with considerable speed.

If the power of four men does not suffice for the carrying out of this idea, it will be easy to compensate therefor by adding a pinion to the axis of the cranks and secondary toothed wheels to the axles of the paddle wheels.

The teeth of these second wheels will mesh with those of the pinions, and by this means one will much diminish the stress that would be required here by the cranks in order to cause the wheels, A and B, and their paddles to revolve.—From Recueil Curieux de Mathematique et de Mecanique, 1733.

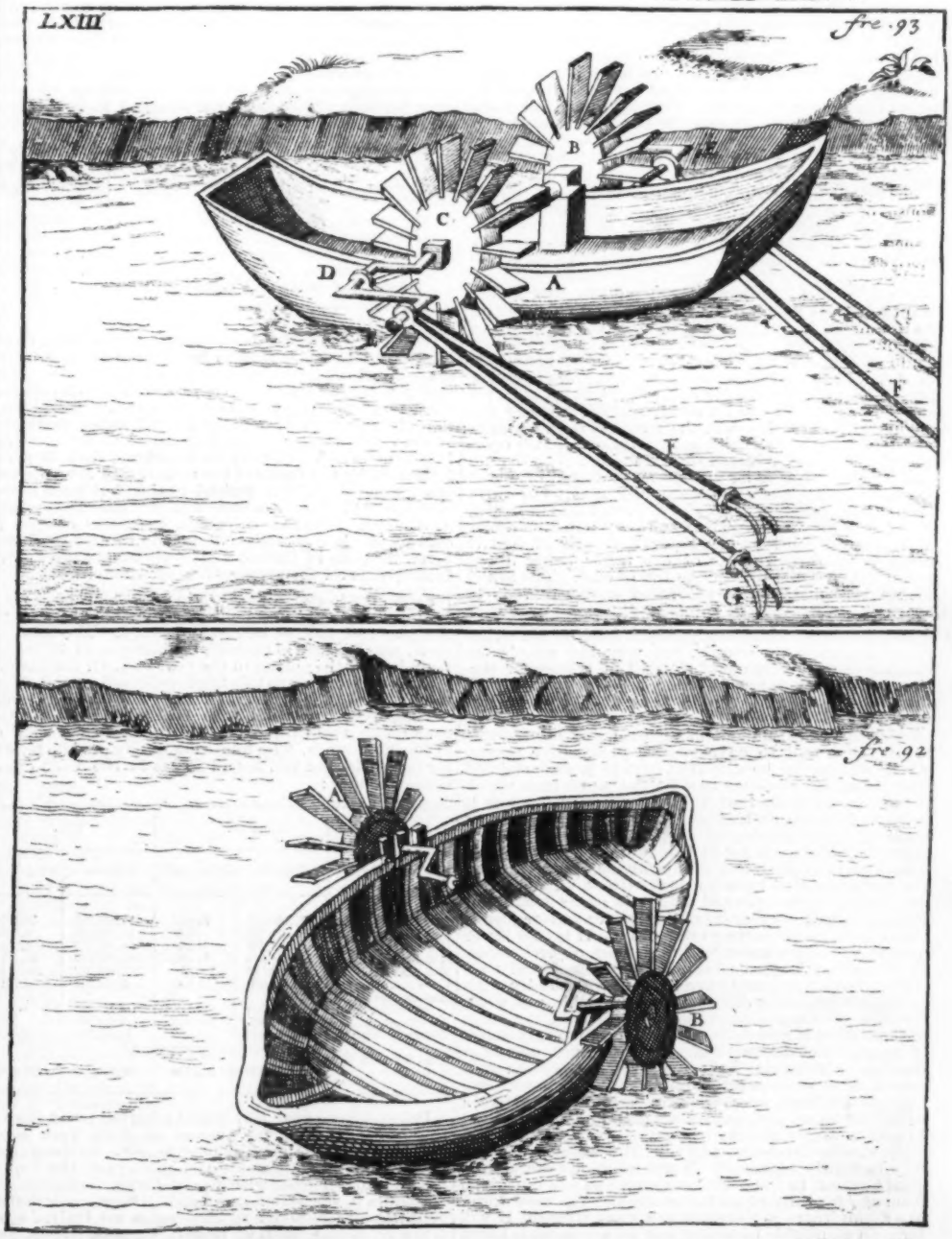
USES OF THE GAS ENGINE.

ACCORDING to a high German authority the distribution of 2,323 gas engines throughout thirty-six representative German cities is as follows:. As these cities range in population (1890) from 3,000 to 348,000, with an average of 68,000, they are excellently illustrative.

Industry.	Percentage.
Printing and lithography	14·4
Pumping	8·6
Textile	7·9
Electric lighting	7·6
Machine shops	5·3
Joiners and cabinetmakers	5·0
Butchers and sausagemakers	5·0
Locksmiths	4·2
Coffee roasters	3·1
Cutlery	2·9
Elevators	1·6
Total	65·6

The remaining 34·4 per cent. is scattered throughout 140 more industries. This would seem to prove that the gas engine is largely the motor of the small industries; but it should also be remembered that Germany is the land of small industries.

Theoretically a pound avoirdupois of calcium carbide should yield 5·89 cubic feet of acetylene gas, but in practice not more than 5 cubic feet is obtained.



MACHINE FOR PROPELLING A BOAT BY MEANS OF PADDLES WITH CONSIDERABLE SPEED AND WITHOUT EMPLOYING MANY MEN.

ENGINEERING NOTES.

The Compagnie Internationale des Wagons-Lits, which controls the sleeping cars on the European Continent, has secured contracts for running its cars on Russian railway lines, and is contemplating the running of a through train from western Europe to the eastern terminus of the Transsiberian Railway.—Uhland's Wochenschrift.

A decree has been issued, or will be shortly, says Architecture and Building, by the Chilean Congress, offering a state bounty of $125,000 to any foreign company or firm which will undertake to establish an iron foundry in Chile on a sufficiently large scale. The Chilean government has been prompted to this action doubtless by the increasing evidences of the existence in the country of iron ore in large quantities.

Aluminum combines with iron in all proportions. Few of the alloys, however, have yet proved of value, except those of small percentages of aluminum with steel, cast iron, and wrought iron. Small amounts of iron have been used with advantage in some casting alloys of aluminum. An alloy of aluminum with a small percentage of copper, tungsten, and iron has been shown to have some advantages for rigidity and strength. Iron as a ferro alloy of chromium, manganese, or similar metals is a convenient and cheap metal to use in hardening aluminum alloys. So far as experiments have yet gone, as a general proposition, other elements can be better employed to harden aluminum than iron, and its presence in aluminum is usually regarded as deleterious and to be avoided if possible. There are very few commercial metals not chemically pure containing iron as does aluminum as made by the Pittsburg Reduction Company; certainly all of the brasses, bronzes, or German silvers contain a larger percentage of iron.—Aluminum World.

The peculiar system by which the city of Amsterdam obtains its water supply from the sand dunes bordering the sea is probably not exceeded in scientific interest by any other method in any part of the globe. These dunes are composed of sand blown up from the seashore, their basis also consisting of sand, although this is mixed with peat at some points, and at the sea level layers of compressed peat are frequently found. It is noticeable, too, that these peat layers are never found on the sides of the dunes next the sea. The rainfall in the dunes percolates through the sand and flows landward and seaward, so that the surface is a cone whose apex is the summit of the dune, which, sloping both ways, forms a continuous watershed. Now, not only is the dune water fresh above sea level, but it is perfectly fresh to a depth of some 66 feet below sea level. This fresh water being found at such depth under the dunes, while the water at the same depth in the immediate neighborhood is salt, goes to prove that either the subsoil must be based on fresh water—the hydraulic pressure of the dune water preventing sea impregnation—or that the water, originally salt, has become freshened by this dune water pressure.

The results of the use as fuel in the electric power houses of the New Haven Railroad Company of the small, partly burned cinders, known as "sparks," obtained by the use of spark arresters on the steam locomotives of the company, are interesting. At the Stamford electric power house sparks have been used exclusively as fuel for almost eleven months and at the Nantasket and Berlin power houses about two months. At Stamford, during the eleven months, there was a cost of 3 mills per horse power hour for sparks with an engine running at unequal "loads." A test made with an engine running with normal load gave a cost per horse power hour of $3\frac{3}{16}$ mills for coal (soft) and $1\frac{9}{16}$ mills for sparks. At the Nantasket power station, running the engine with variable loads, the cost has been $4\frac{3}{16}$ mills for sparks. At the Berlin power station—which operates the third rail between that place and New Britain and for about ten miles between the latter city and Hartford—with the engine running about one-third the normal load, the figures have been 6 mills for coal and 3 mills for sparks. The figures are based on a cost at the power stations of $3 per ton for coal and 72 cents for sparks, two tons of the latter being about equal in heat efficiency to one ton of coal. The Stamford power station has consumed about 18 tons of sparks a day.

The nails with which everybody is familiar are either round or square in section, but very few people encounter or make any use of the nail of triangular section, although it is now several years since these were introduced, says The Trade Journals Review. Naturally, those who are interested in the manufacture or sale of this patent nail claim a great many advantages for it. It is said to have greater penetrative power, which will hardly be disputed, but it is also claimed that it has less tendency to split the wood into which it is driven. Well, that will depend upon how it is used, and inasmuch as there is less displacement of material in the driving of such a nail, it is possible there may be something in it. But another property it undoubtedly possesses will hardly be appreciated by the workmen who have to deal with it. The barbed notches which are plowed into two of its triangular sides must give it greater holding power and render it much more troublesome to withdraw. It is that latter quality which workmen will find most objectionable. It frequently happens both in permanent and temporary work that parts have to be taken asunder with as little breakage or deformation as possible, and when the nails offer much resistance to extraction, the labor of separation is greatly increased, and the parts suffer ill usage, if not destruction. It is true that a greater number of triangular nails of a given size will be contained in a given weight, but as the triangular nail cannot but have less strength in its section than a square or round one, carpenters may find it expedient to use a larger size in triangular form than would otherwise be necessary, and thus the weight of metal may be nearly equalized. These opinions are simply such as occur to the practical mind, and are not given from any hostility or prejudice against the new form. We admit there are certain purposes wherein it will form an admirable fastening, but we are dubious about its advantages being so numerous or so obvious to the ordinary carpenter or pattern maker as to insure its superseding the older and better known forms.

MISCELLANEOUS NOTES.

The world's annual output of Portland cement is estimated at about 35,050,000 barrels, of which amount Germany produces 13,500,000; Great Britain, 8,300,000; France, 3,000,000; United States, 2,300,000; Belgium, 2,250,000; Russia, 2,000,000; Austria, 1,000,000; Italy, 800,000; Norway and Sweden, 500,000; and Denmark, 400,000 barrels.

In the eighteenth century the French government bought from a dyer the secret of Turkey-red dyeing, which he had learned in the Orient, and then published the secret. The consequence was that Turkey-red dyeing was practiced all over Europe, and Adrianople, which had been the main seat of that industry, soon lost its importance.—Prometheus.

The Russian Minister of War has ordered aluminum horseshoes for the cavalry. The first trial is now being made by the Finland dragoons, and the horses are shod as follows: A shoe of the new aluminum model is placed on one foot, the three remaining shoes being of the kind ordinarily in use. The trial, which has already lasted twelve weeks, seems to be satisfactory, as the aluminum is lighter, wears out less rapidly, and is less affected by mud and moisture than the ordinary shoe.

A recent number of Zeitschrift für Elektrochemie discusses a process for the extraction of phosphorus and calcium carbide from basic slag. In this process tricalcium phosphate is mixed with an excess of powdered carbon and heated in an electric furnace, whereby calcium carbide, phosphorus, and carbonic oxide are formed. The phosphorus passes over into a condenser and is recovered, the yield being claimed to be 80 per cent. of the total present in the mixture. The writer describes a series of experiments made by himself with a view of converting the phosphates of these slags into phosphides, the latter to serve as a deoxidizing material for overblown iron. The results, however, proved negative, the lime in the slag giving off its phosphorus and changing into calcium carbide.

The crops to be raised on the sewage filter beds at Altoona, Pa., this year, will include oats, corn, potatoes, cabbages, onions, and peas. A record of the dosing of these beds during the last five months of 1897 shows that on the average each of the thirty-six beds received sewage for 308 hours, which disappeared in 110 hours after the flow was stopped. Some of the beds were not used the whole of the time, the average time in use being 129 days, during 19 of which the beds were wet—sewage being applied or not having disappeared—leaving 110 days on which the beds were dry. The exact amount of sewage treated is not known, but is estimated at 60 gallons per day for 13,000 people, or 780,000 gallons. The total area of the beds, including embankments, is 64,469 acres, an average of 1,791 acres per bed. The level area adapted to cultivation is 56·8 acres.

The total population of the Hawaiian Islands, according to the latest census taken there, was something more than 100,000, divided according to nationality as follows:

Americans	3,080
Japanese	25,407
Chinese	21,616
Portuguese	15,291
Hawaiians (pure and mixed)	39,504
British	2,250
Germans	1,433

It is a very remarkable circumstance that out of this comparatively small though heterogeneous population there are 14,000 lepers, and in spite of all endeavor to stamp it out, leprosy is increasing. It is also a peculiar circumstance that, while we broke a treaty with China to exclude her people from the United States, we should annex 21,000 Chinese to the population of the country. It is true, says The Nashville American, that they are forbidden by the terms of the annexation act to enter other portions of the United States, but such a prohibition will hardly stand against the Fourteenth Amendment to the Constitution, if any one chooses to contest it. It is certain that people of Chinese blood hereafter born in Hawaii will be citizens of the United States, with all the prerogatives of other citizens.

According to statistics given in a late issue of Mineral Industry, the output of copper in the United States for the year 1897 was the largest on record. The total as given was 510,190,719 pounds, an increase of 30,384,536 pounds over the output of the year 1896. Of the various States contributing to this unprecedented output, Montana headed the list with a total of 237,158,540 pounds, Michigan being second with 145,839,749 pounds, Arizona being the third from the front with a total of 81,019,922 pounds. The following table gives the figures for both 1896 and 1897 for all States in the Union producing copper:

States.	1896.		1897.	
	Pounds.	Long Tons.	Pounds.	Long Tons.
Arizona	73,745,321	32 922	81,019,922	36,170
California	1,971,545	880	14,120,020	6,308
Colorado	9,539,945	4,259	9,437,663	4,213
Michigan	144,058,594	64,312	145,839,749	65,107
Montana	238,958,164	102,213	237,158,540	105,874
Utah	3,550,050	1,585	3,864,821	1,721
Eastern and Southern States	3,750,124	1,674	3,727,989	1,664
All others	2.0 0.000	915	2,018,999	901
Copper in sulphate	12,163,210	5,430	13,003,326	5,805
Total domestic production	479,806,183	214,149	510,190,719	227,763

Prices for the year 1897 scored a higher point than in the previous year, the average in New York being 11·29 cents in 1897, against 10·88 in 1896. In the world's production of copper for the past year the United States leads the list, with Spain, Chile, Germany, and Australia in succession as named. Other contributing countries of less note and importance are Italy, Japan, Norway, Russia, Mexico, Bolivia, Canada, Africa, Sweden, and Austria-Hungary. The total production of all countries is placed at 418,677 metric tons, or 31,470 tons more than in 1896.

SELECTED FORMULÆ.

Growth of Grass Prevented.—The growth of grass between bricks in a wall may be effectually prevented by the use of bluestone. After cleaning out the seams to a depth of a quarter of an inch, scatter a little powdered commercial bluestone and then lightly sweep it over, so as to leave a little powder in the cracks. When this is washed in by the rain, it will prevent vegetable growth and not appreciably stain the brick. A pound of bluestone, costing not over 10 cents, will suffice for fifty or more yards of paving, and last for years.—University of Virginia, July, 1898.—F. P. Dunnington.

Diamond Ink.—The so-called "diamond inks" are liquids used for etching glass. The most common method consists in mixing ammonium fluoride with precipitated barium sulphate and decomposing with sulphuric acid. Here is a formula:

(1)
Ammonium fluoride	1 ounce.
Barium sulphate	2 "
Sulphuric acid, a sufficient quantity.	

Rub the two salts together, transfer to a platinum, lead or gutta percha vessel, and add enough sulphuric acid to produce a creamlike paste. Apply with a quill or camel's hair pencil.

Dieterich gives the following:

(2)
Ammonium fluoride	2 parts.
Barium sulphate	2 "
Hydrofluoric acid, fuming	Sufficient.

Mix the salts in a porcelain mortar, transfer to a platinum or lead vessel, and by means of a platinum wire stir in enough of the acid to make a thin paste. Writing may be performed with a steel pen; allow the ink to remain on the glass for one-half hour, and then wash off with water. To make the etching more visible, rub in a little printer's ink.

(3) Dissolve 18 grammes of sodium fluoride and 37 grammes of potassium sulphate in 250 c. c. of water. Also, dissolve 7 grammes zinc chloride in 250 c. c. of water and add 32·5 grammes hydrochloric acid. For use mix equal parts of the solutions. The time required for etching is one-half hour.

Hydrofluoric acid is an extremely dangerous substance to manipulate, and therefore great care should be taken in using any of the above preparations. The vapor of the acid, even when diluted with air, has a most irritating and injurious effect upon the respiratory organs, and if inhaled in the pure state it may cause death. The liquid acid is powerfully corrosive, and a single drop of it upon the skin causes the most painful ulcerated sores, accompanied, it is said, by distressing, aching pains through the whole body.—Pharmaceutical Era.

Cleaning Marble.—(1) Mix with water 5 parts of common soda, 2½ parts powdered chalk, and 2½ parts of powdered pumice stone. Rub the spots well with this mixture, then wash off with soap and water.

(2)
Sodium carbonate	2 ounces.
Chlorinated lime	1 "
Water	14 "

Mix well and apply the mixture (magma and liquid) to the marble with a cloth, rubbing well in, and finally rubbing dry. It may be necessary to repeat the operation.

(3) The Era Formulary gives the following process for removing oil stains from marble: Apply common clay saturated with benzine. If the grease has remained long enough, it will become acidulated, and may injure the polish, but the stain will be removed. The marble may then be washed with a solution of soft soap in water.

From Lippincott's "Book of Instructions" for the soda fountain we take the following information relating to the care of marble: The action of acids, viz., sulphuric, carbonic, citric, phosphoric, lactic, etc., or the fumes emitting therefrom, employed in carbonating and dispensing soda water, attacking marble, is very injurious to its polish; the front of the apparatus, marble slabs, etc., exposed to the spattering of soda water in which one or more of these acids are present should be immediately rinsed with water and afterward rubbed quickly with a clean, soft cloth until perfectly dry. Frequent applications of pure olive oil to black or fancy marbles, rubbed vigorously with a soft, smooth fabric, will assist toward retaining their original appearance. Under no circumstances should oil or soap be applied to onyx, Italian white, French blue or Bardillo marbles. Stone of this description should be washed frequently with pure water and afterward rubbed briskly with a clean chamois until it assumes a glossy appearance. A saturated solution of beeswax in turpentine, rubbed into the pores of highly colored marble showing signs of dimness, and afterward removed by rubbing it smartly with a soft, smooth cloth, will restore its original luster. Light colored marbles, and especially onyx, should be kept dry and bright by burnishing the surface frequently with a clean chamois. To prevent Belgium black marble from turning gray, it should be oiled and rubbed freely at least once a week. By keeping the pores of marble filled with oil, a film is formed over the surface which becomes almost impervious to the action of acids, etc.—Pharmaceutical Era.

Dusting Powder for Perspiring Hands.—

Zinc oleate	10 parts.
Bismuth subnitrate	20 "
Beta-naphthol	1 "
Starch	69 "

—Südd. Ap. Ztg.

Washing and Bleaching Liquid.—The following was recommended in a German medical journal not very long since as being the most efficient and least harmful:

Soda (sodium hydrate)	150 parts.
Resin	75 "
White soap, shaved up	50 "
Alum in coarse powder	50 "
Sodium carbonate (commercial)	200 "
Sodium or potassium silicate	200 "
Water	600 "

Bring the water to a boil, and in it dissolve the silicate, and add the resin. As soon as solution takes place add the remaining substances. A tablespoonful is said to be sufficient for an "ordinary wash." You can easily determine the quantity necessary, by a few experiments.

[Continued from SUPPLEMENT, No. 1186, page 19009.]

HIGH EXPLOSIVES AND SMOKELESS POWDERS AND THEIR APPLICATIONS IN WARFARE.

By HUDSON MAXIM.*

IN order to arrive at a correct understanding of what may be accomplished by this system of throwing high explosives from ordnance, let us take the present 12-inch sea-coast rifle as a basis for our calculations. This gun weighs fifty-two tons, and throws a projectile weighing, loaded, 1,000 pounds, at a maximum velocity of 2,350 feet per second on a pressure of 35,000 pounds to the square inch, with a powder charge of 250 pounds Maxim-Schupphaus smokeless powder, grains three diameters long and having seven perforations. The bursting charge of the 12-inch projectile is only 37 pounds of black rifle powder.

Now, in place of the above 12-inch sea-coast rifle throwing a 1,000 pound steel shell filled with only 37 pounds of black powder, a torpedo gun could be constructed which would have the same weight and which would cost the same, both for the gun and for mounting, as the 12-inch gun, but which would have a caliber of 24 inches, and which, with the same factor of safety that the 12-inch gun stands (35,000 pounds to the square inch), would sustain a working pressure of 17,000 pounds at the breech and 10,000 pounds at the muzzle.

The torpedo gun would have practically the same outside dimensions as the 12-inch gun for the rear half of its length, the diameter being a little larger forward.

Now, suppose we consider both guns to be of equal length, and the length of travel of the shot the same, and let us estimate in the 12-inch gun the working pressure throughout its length to average 22,000 pounds from breech to muzzle, we have against this in the torpedo gun an average working pressure from breech to muzzle of 11,000 pounds—just one-half the average pressure of the 12-inch gun.

But the base of the projectile in the 24-inch gun is four times as great as that in the 12-inch gun. Consequently, we have a pressure of 11,000 pounds exerted through the same distance and over an area four times as great. Hence, the torpedo projectile is thrown from the gun with twice the muzzle energy as the 12-inch shell. This enables us to throw a projectile of twice the weight as the 12-inch shell, or weighing one ton, at the same velocity as the present 12-inch shell is thrown, and the additional half ton of weight may be high explosive.

In other words, the torpedo projectile would consist of half a ton of steel and half a ton of high explosive, and we have, therefore, without any sacrifice of velocity, half a ton of steel and half a ton of explosive, in the place of 963 pounds of steel and 37 pounds of black rifle powder.

The high explosive which would be thrown would, pound for pound, be at least four times as powerful as black powder. This is a very low estimate. Consequently, the bursting charge thrown in the torpedo shell would be equal to more than two tons of black powder, and equal in force to the combined bursting charges of more than one hundred 12-inch shells.

By the sacrifice of a little velocity, but still leaving us a velocity of 2,000 feet per second, we may make our aerial torpedo to weigh a ton and a half, and to consist of a ton of steel, carrying a bursting charge of half a ton of high explosive. This projectile would be sufficiently strong to enable it to penetrate the deck armor of any battleship in the world before exploding, or to penetrate the belt armor of protected cruisers like the "New York," and explode inside the vessel. That such an explosion would be destructive in its effects I think all will be willing to grant.

The fuse to be employed is one of the chief features of the aerial torpedo. The question of fuse has always been one of the principal features of the problem of successfully throwing high explosives from ordnance. Briefly, it is constructed in such a way as to absolutely preclude any danger of premature explosion in the gun, and when the projectile strikes the target, the action of the fuse is sufficiently delayed to permit the penetration of the projectile to a desired depth in earth or water, or to pass through light armor before exploding.

Let us now see what may be done with but a very slight change in present forms of ordnance and in present forms of shell. Let us take a gun of the same weight and cost as the present 12-inch 52-ton sea-coast rifle, and let us construct it to throw a projectile weighing 1,500 pounds—1,000 pounds of steel and 500 pounds of high explosive. The caliber of the gun would be about 20 inches. The projectile thrown would have a velocity considerably greater than the present 1,000-pound 12 inch shell, carrying a bursting charge of only 37 pounds of black powder.

Now, when we take into consideration the fact that it will not cost any more for a gun to throw aerial torpedoes, carrying bursting charges a hundred times as powerful as are now thrown, and without any sacrifice in velocity, but that we may even attain greater velocity, flatness of trajectory, and directness of fire than are now attained with high power guns, and still throw enormous charges of high explosives, the value of this system ought to be apparent.

The system involves no radical departure from present forms of ordnance. The aerial torpedo involves nothing questionable or intricate in its construction, and no new or untried law, and, as has already been stated, there are several high explosives which may be thrown with perfect safety.

Lyddite, which is simply picric acid, is already employed by the British government for filling shells for high power guns, and this same material, either alone or admixed with other ingredients, has been long used by some of the Continental European powers.

In the Westminster Gazette of August 26 last, it is said that "The reports to hand from the Soudan expedition indicate that in the attack upon Omdurman great reliance will be placed upon the mischief-making power of the new Lyddite shell. It is stated that when tried at Abu Sieh, Cairo, the effect of the time bursts was simply terrific, and it is asserted that the concussion of a burst can have effect 600 yards to the front and 300 yards to the rear."

What I propose is simply to throw larger quantities, but without subjecting the explosive to any greater shock in the gun than that to which it has been already subjected and been found to successfully withstand.

This should be borne in mind, that the same explosive that is now widely used for filling shells for high power guns may be used to fill aerial torpedoes, and that, in the aerial torpedoes, it will not be subjected to any more shock than that to which it is now subjected.

As already stated, it is the length of column of the explosive in the projectile that must be taken into account in considering the shock of acceleration upon it. In the aerial torpedo proposed by me, the column of explosive would be subdivided by a strong cross partition, and, no matter how large the shell may be in cross section, the shock is no greater than as though it were but a few inches.

Naval and military authorities must soon give due consideration to the aerial torpedo. From half a ton to a ton of high explosives can certainly be thrown with absolute safety and great accuracy at all fighting ranges at sea, and if such quantities of high explosive, striking and exploding on board a battleship by impact upon its superstructure, will destroy the vessel or throw it out of action, or if such quantities, when projected into the water, and exploding as submarine mines adjacent to the hull of a battleship, will suffice to blow her up or sink her, then the first shot of the aerial torpedo gun proposed by me will render obsolete every battleship in the world.

Immense sums of money will no longer be expended in armored protection which will not protect, and in the construction of huge and ponderous fighting machines whose very size renders them a more easy prey to the torpedo gun than a small and light cruiser, simply big enough to provide a portable and stable gun platform. If a projectile can be thrown which shall be sufficiently destructive to demolish anything and everything it hits, then, obviously, thereafter centralization of men and expense must be abandoned and men and weapons must be dispersed in order to form as many and as small targets as possible. Navies must fight in skirmishing order, exactly as armies on land now do.

If the battleship, forming a target ten times as great, offers no greater protection against the aerial torpedo than the small, unprotected cruiser, and costs ten times as much and carries ten times the number of men, it is certainly not more than one-tenth as efficient a fighting machine. Anything revolutionary in character, however meritorious, always has a hard fight for recognition, especially in overcoming the opposition backed by enormous vested interests. It would be easier with a few cruisers armed with aerial torpedoes to make a scrap heap of every battleship of the combined navies of the world to-day than it will be to even secure the system a place for once in the line of battle.

If there is even a fighting chance for the aerial torpedo to work the revolution in naval construction predicted, then this matter is a subject for serious consideration, especially by the United States government, before making the enormous expenditures in battleships which Great Britain has made. Half a million dollars will build and arm a light torpedo cruiser which will carry one 24-inch torpedo gun and two torpedo mortars. This will demonstrate the efficiency of the system. If it fails, it costs but $500,000; if it succeeds, it will save $500,000,000. The battleship must go.

The great distance to which enormous quantities of high explosives may be thrown by torpedo guns and mortars and the hitting qualities of these weapons, when the enormous size of the target is taken into consideration within whose area a torpedo, striking, will destroy a warship, renders these weapons of supreme importance for coast defense.

Aerial torpedo guns, when once successfully tried, either on land or sea, will cause a revolution in coast fortifications as well as in war vessels. Aerial torpedoes penetrating deep into earthworks before exploding will be disastrous. It will then be the weapon, rather than means of protection, that will be the dominating factor in both attack and defense. The cost by present methods in ammunition and wear and tear of guns in bombarding coast fortifications or towns is quite equal to the amount of damage done. This will all be changed by the introduction of aerial torpedoes.

The American fleet expended more than two million dollars' worth of ammunition hurling shot and shell at the Santiago hills, and the damage wrought was quite insignificant, probably not more than ten per cent. of what it cost the American government in ammunition alone.

The "Vesuvius" threw a few guncotton shells carrying only 200 pounds of guncotton and without any power whatever of penetration. Not much could be expected of these.

Suppose a few aerial torpedoes weighing a ton and a half, with a bursting charge of half a ton, and capable of penetrating deep into the fortifications before exploding, had been employed, would not the result have been vastly different? Would not enormously greater destruction have been wrought?

The lessons of the present war do not, as claimed by certain persons, teach us the uselessness of torpedo boats and of torpedo warfare, and nothing has been learned upon which to found any higher opinion of the battleship than we had before the war. The great lesson taught is the superiority of the American gunners and Americans as fighters.

Suppose, for example, that Cervera had had such a number of torpedo-boat destroyers, of the "Pluton" and "Furor" type, as could have been constructed for what the American battleship "Oregon" cost—say twenty of them—and suppose those torpedo boats had been armed and equipped with American guns and ammunition, American torpedoes, and manned by Americans instead of Spaniards, and had they sallied forth at night and made a determined attack upon our fleet, is it not probable that they would have succeeded in destroying more of our war vessels than they themselves cost before they could have been destroyed?

Furthermore, suppose there had been mounted upon the Santiago hills torpedo guns capable of throwing half a ton of high explosive over a radius of from eight to nine miles, might not the results have been different?

In these ante-millennium times, war is occasionally a necessary contingency, and when it comes we want the best tools we can get to fight with, and it is a crime for a nation not to be prepared for war, a crime against those who will be called upon to defend the country in time of war. It is a crime for a nation not to be abreast of the times in arms and equipments.

Improved guns and ammunition, improved methods for the employment of the most destructive agencies of offense and defense, are but means of saving life. Modern armies and navies are but elaborate and efficient life-saving systems, and are as humanitarian in nature as the life-saving services along the coast of civilized countries, whose duty is to warn vessels of danger and to succor those who may be cast away. The fort is as humanitarian in its nature as the lighthouse, and the sea-coast gun as much an implement of mercy as the gun that throws the life line to a stranded wreck.

The cost to this country of the present war with Spain, above what it would have been had the country been prepared for war, is difficult even of approximation—prepared in every sense, as well as with armaments; I mean, prepared to move and feed its soldiers, and care for the sick and wounded.

It is doubtful if there would have been any war had not Spain been encouraged by her belief in our weakness or unpreparedness; for it was not only generally believed in Spain, but by many in other European countries, that Spain would at first have the best of the fight. The world has been taught a lesson by a reminder of the fighting qualities of the American character. We have also ourselves been taught a lesson which the country ought not soon to forget—the necessity of being prepared for war.

The country which finds itself involved in war in a state of unpreparedness can make good deficiencies in such respects only at the cost of great sacrifice of life.

Had the American troops before Santiago been fully equipped with automatic machine guns, Mauser magazine shoulder rifles, using smokeless powder, and with siege guns throwing high explosives, the loss of life would probably not have been more than one-tenth as great as it has been. For soldiers to go into the field in this mechanical age with single loading guns like the Springfield rifle, of short range and high angle fire, throwing big slugs of lead with black gunpowder, is a crime against every man that fights and a slap in the face of patriotism. For proud and patriotic Americans, who lead the world in mechanical inventions, to be forced to serve as soldiers in the field with obsolete arms, and face Spaniards using Mauser guns and smokeless powder, is simply wicked.

Those who have been in authority in this country, and whose business it has been to attend to these matters, are more responsible for the loss of life at Santiago than the Spaniards. Many valuable lives could have been saved by due progressiveness of those whose business it should have been to be progressive.

Every American citizen is exceedingly proud of the feats of all our naval and military heroes. But is there any American citizen who does not feel a pang of shame when he reads of our inability to locate the source of the Spanish fire, owing to their using smokeless powder, and that much of the mortality to the Americans before Santiago was due to our using black powder, and our batteries and troops being easily located by the Spaniards.

War must be looked upon as a business, and subject, like any other business, to business principles. War is the business of destruction of life and property of an enemy, and has no regard for the sacredness or pricelessness of human life. Lives become part of the paraphernalia of war, and lives and property become representative in value. The art of war consists in the employment of means and instruments to accomplish the desired purpose with the minimum of risk, expenditure, and loss on the investment.

The history of nations is the history of wars. The millennium of secure universal peace is yet far off. There will be need of guns just so long as one man, through eyes of injustice, sees any use for another man's property, or until all nations shall unite in a common federation, a universal family of mankind, bound to peace under laws made in the common interest, when shall be realized that ideal society mentioned by Tennyson—

"The parliament of man, the federation of the world."

At best war is cruelty, but it is not only often a necessity, but unavoidable, and, once engaged in, should be made as terrible and destructive as possible while it lasts, in order that it may be brief as possible, thus minimizing the evil in the aggregate.

Not only do swords and bayonets, guns and gunpowder, torpedoes, and high explosives constitute the weapons of war to-day, but the steamboat, railroad, telegraph, the woolen and the cotton mill stand on the plane with the forge; the chemist, electrician, engineer, and inventor find duty as serviceable to their country as does the bleeding soldier; and all the vast industries of a great commonwealth unite with its husbandry to supply the sinews of war. By just division of labor, the plowman, artisan, scientist, and inventor strike as nobly for their country and render her equal service as though they were to fight and bleed and die upon the field of battle.

One man, with a Maxim gun, is worth more in a fight to-day than would be a hundred men armed with the old-fashioned muzzle loading rifles used as late as the American civil war. The new magazine rifle makes a single soldier more than a match for a dozen men armed with the old weapons.

A troop of artillerists operating modern quick-firing guns, with shrapnel and canister, could stand against ten times their number armed with the old smooth-bore muzzle-loading field guns. What does this mean? It means that only one-tenth as many men need be sent away to war, while the remaining nine-tenths may stay at home.

It may be argued that an enemy would be equally well equipped. Very true. But his equipments and the home industries producing them demand of him

* Lecture delivered before the Franklin Institute, Philadelphia, on Tuesday, September 20, 1898.

also that the nine men work and only the tenth man fights.

There can be but one interpretation as to the results upon civilization of improvements in implements of war, and it is that more will be done by money and machinery, and less fighting done by hand, permitting and demanding that larger numbers remain at home engaged in industrial pursuits, while the home is defended less by blood and more by the fruits of industry.

The most deadly and destructive implements of war are the most humane, and the producers of them may justly be looked upon as humanitarians. The best guarantee of peace is to be in a position to make a breach of it as undesirable as possible to an enemy. The greatest security against receiving heavy blows is to be in a position to strike them. Peace is made most secure by being prepared for war, by pushing to the highest state of development possible the weapons and means of offense.

The inventors of deadly engines of war place in the hands of scientific and enlightened nations the means controlling wars. Such inventions have put a limit to the time when barbarian hordes can overrun and subdue the earth, to ravage, destroy, and enslave, by sheer brute force and power of numbers.

SOME NEW HAND CAMERAS.

SMALL hand cameras continue to multiply, and are even becoming stereoscopic. It has been found that it is possible to dispense with the enlarging of small size photographs, provided that the latter are looked at in a stereoscope. This was known forty years ago, but the fact has probably been lost sight of. The apparatus costs a little more, since there are two objectives; and it is also a little more cumbersome, although one can have made an apparatus of this kind that may be easily carried in the coat pocket.

A single image pocket apparatus of small size and weight, and that may easily be procured, is the Eastman Kodak, which gives $2\frac{1}{2} \times 3\frac{1}{2}$ inch images upon a film. It is but $1\frac{3}{4}$ inch in thickness and weighs, all charged, about twelve ounces. In order to reduce it to this size, the bobbins have been placed at the sides. The front, which carries the objective and the shutter, fits in between these when the bellows are folded, and there is no projecting part to interfere with putting the apparatus in the pocket (Fig. 5). The film, which may be kept for quite a long time, is sold wound upon a spool, which is placed at B. It permits of making twelve exposures. Each of its extremities terminates in a long strip of black paper, so that it is possible, in broad daylight, to begin the unwinding in order to supply the roller, C, which is designed to store it after each exposure. This roller, too, after it is fully wound may be easily replaced by another. The number of exposures is therefore indeterminate, and depends only upon the number of the rollers that are carried along.

As a general thing, manufacturers continue to employ glass plates by preference. M. Caillon is constructing a double camera for $2\frac{1}{2} \times 3\frac{1}{2} \times 5$ inch plates, the magazine of which (Fig. 4) is very well conceived. The changing of the plates is effected by pulling out the back of the camera after the manner of a drawer. The whole package of plates, save one, is carried along, and the one to be exposed is brought to the back of the empty space by two springs, R. In this way the change can be made very surely, whatever be the position of the apparatus. The charging is done through an aperture in the side, closed with a block, B. The piece that carries the shutter and objective is provided with a rack that permits of effecting the focusing; and the manufacturer, for the mounting of the objective, has left sufficient margin for the screwing on of any kind of a lens that may be desired. This is an excellent idea, since every one has decided ideas upon the subject of objectives, one person preferring those of foreign make, while another considers those made in France good enough for him.

M. Irumberry's "Peri-jumelle" (Fig. 6) is furnished in the same sizes as the preceding and is provided with Zeiss objectives. The system of changing the plates is entirely new, and the mechanism is very interesting. The top, S, of the magazine, M, is raised when the ring, B, that is fixed to it is pulled, and through this motion the plate that has just been exposed is removed by two levers, L, above the package of plates, which remains in place. A half revolution is then given to the ring, B, and the levers carry the plate, P, to the back of the magazine, where it lodges behind the others when the lifted part is shut down. It is a reminiscence of the bag apparatus, but here everything is done mechanically.

The best known system of plate changing is that found in the Hanau frame, which the Carpentier double camera has contributed toward popularizing. M. Gaumont has applied it to a $3\frac{1}{4} \times 5$ inch apparatus which he calls the "Spido" (Fig. 2), and which he has provided with all the improvements that are capable of contributing toward facilitating the maneuvering and obtaining irreproachable negatives. The objective is a Zeiss-Krauss one mounted upon a Decaux shutter, the performance of which is, as well known, excellent, and the pneumatic moderator, M, which permits of an exposure or of speeds that range from $\frac{1}{4}$ to $\frac{1}{125}$ of a second, which are readily adjusted according to the scale marked upon the apparatus. The front is provided with a rack for a focusing starting from 3 feet.

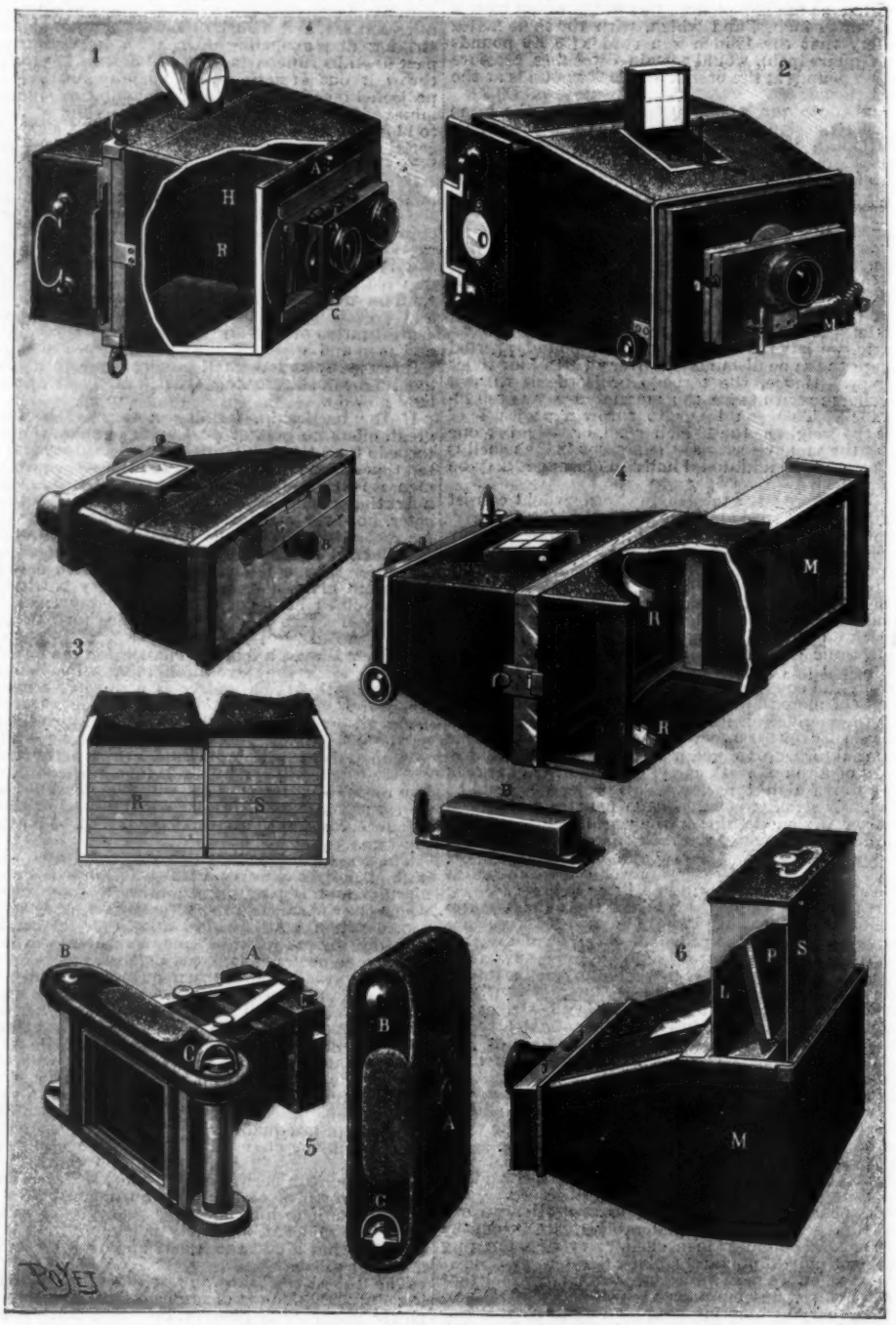
The "Spido" is made likewise for stereoscopic views. The same is the case, moreover, with all the apparatus that we have hitherto described as simple ones, such as the Mackenstein, Joux, Zion, and Bellieni. As regards the latter, we may add that the manufacturer has just finished a model designed for the use of films on a roller, and capable of giving 100 double views.

Of the new comers we must mention the Leroy "Stereocycle" (Fig. 3), which is made in two styles, both stereoscopic, one giving $2\frac{1}{2} \times 2\frac{1}{2}$ inch images and the other $2\frac{1}{2} \times 2\frac{1}{2}$ inch ones. There is no focusing. The objectives employed are the Kock short focus ones, and all the planes are well defined, starting from 5 feet.

The shutter has several speeds for instantaneous photographs. The method of changing the plates is original, and is complicated with no mechanism. The plates opposite each objective are independent, and are, as usual, placed in small frames, which are here of aluminum. One of the packages, R, thus formed is not so high as the other, S, of the thickness of the frame; but ordinarily, a button, B, placed behind the magazine brings the plate above the level of its neighbor, that is to say, to the focus of the objective. In order to effect the change, the button is loosened and the apparatus is turned around in the direction shown by the arrow.

At the beginning of the inclination, the plate of the higher package slides into the space remaining vacant above its neighbor, and it is this one that then becomes the upper. The revolution of the apparatus continuing, it gives up its last plate to the other, and so on, so that after the apparatus has made two entire revolutions, the two plates that have just been exposed are underneath, and are replaced in front of the objectives by two others. Two apertures, provided with red glass, G, are formed in the back of the magazine, in order to permit of controlling the operation through a reading of the figures inscribed upon the back of the frame.

Finally, we have an apparatus (Fig. 1) devised by M. Turillon, the well-known manufacturer of objectives. The object of it is to utilize a $3\frac{1}{4} \times 5$ inch plate for



HAND CAMERAS.

1. Turillon camera instantaneously convertible into a stereoscopic apparatus. 2. The Gaumont "Spido." 3. The Leroy "Stereocycle." 4. The Caillon double camera. 5. The pocket Kodak. 6. The Irumberry-Carette "Peri-jumelle."

taking a simple photograph of this size or two $2\frac{1}{2} \times 3\frac{1}{2}$ inch stereoscopic views. This apparatus, which includes two ordinary double frames with curtain, or a magazine frame, is provided in front with a piece upon which are mounted two objectives and a single shutter.

This piece upon being shifted permits of bringing one of the objectives opposite the center of the plate, or of placing the two objectives in such a way that each of them shall be opposite one of its halves. In this case, a separation becomes indispensable, since each objective might cover the entire plate. This separating is effected by turning down, through external buttons, A C, two shutters, H B, which are ordinarily placed against the sides of the camera, and which then meet each other so as to form a continuous vertical partition that divides the plate into two equal parts. With this instantaneously transformed apparatus, one will therefore have a choice between a single $3\frac{1}{4} \times 5$ inch negative and a stereoscopic one.—For the above particulars and the engravings we are indebted to La Nature.

SHIPS' CRANES.

ELECTRIC cranes have now been used for some time on the Norddeutscher Lloyd's steamers. They are all built on the same model, with a lift of about 17 feet, in two sizes, for loads of 3 and $1\frac{1}{2}$ tons respectively. As many as 16 have been erected on one vessel, the power station of which is worked by four steam dynamos, which, working continuously, give 75 kw. for lighting and 90 kw. for power purposes. At 105 volts there are 210 turns. Only two of these dynamos are required for 16 cranes, one being reserved for the supply of current for lighting purposes and the other for a stand-by. The liftwork consists of a simple worm and wheel gear fixed to a 25 horse power motor of 700 revolutions, which latter increase by decreasing load up to $2\frac{1}{2}$ times, when the hook is empty. The turning motor has a double worm and wheel, and a cogwheel transmission without self-acting stop. For the latter purpose a hand brake is fixed upon an elongation of the motor axle, a slight pressure upon the footplate of the brake being sufficient to stop at once a load descending at the maximum speed. Two marine controllers, behind which are fixed two resistances of 32 horse power capacity, serve to start, regulate, and turn the motors. Both are directed by a single lever which is turned in the direction in which it is desired to move the crane. The arrangements of both sizes of cranes are identically the same, therefore the smaller ones work with about the same speed. The following figures are given in the Zeitschrift für Elektrotechnik for the large and small sizes respectively:

Load	3 tons.	$1\frac{1}{2}$ tons.
Lift	$5\frac{1}{2}$ yards.	$5\frac{1}{2}$ yards.
Speed when loaded.	0·33 yard.	0·63 yard.
Speed when empty.	0·6—0·75 yard.	1·1—1·3 yard.
Lift motor	25 h.p., 900 revs.	25 h.p., 900 revs.
Speed of turn at the hook	4 yards per sec.	4 yards per sec.
Turning motor	7 h.p., 700 revs.	7 h.p., 700 revs.

Useful effect of the total cranes, inclusive of motor, 25%.

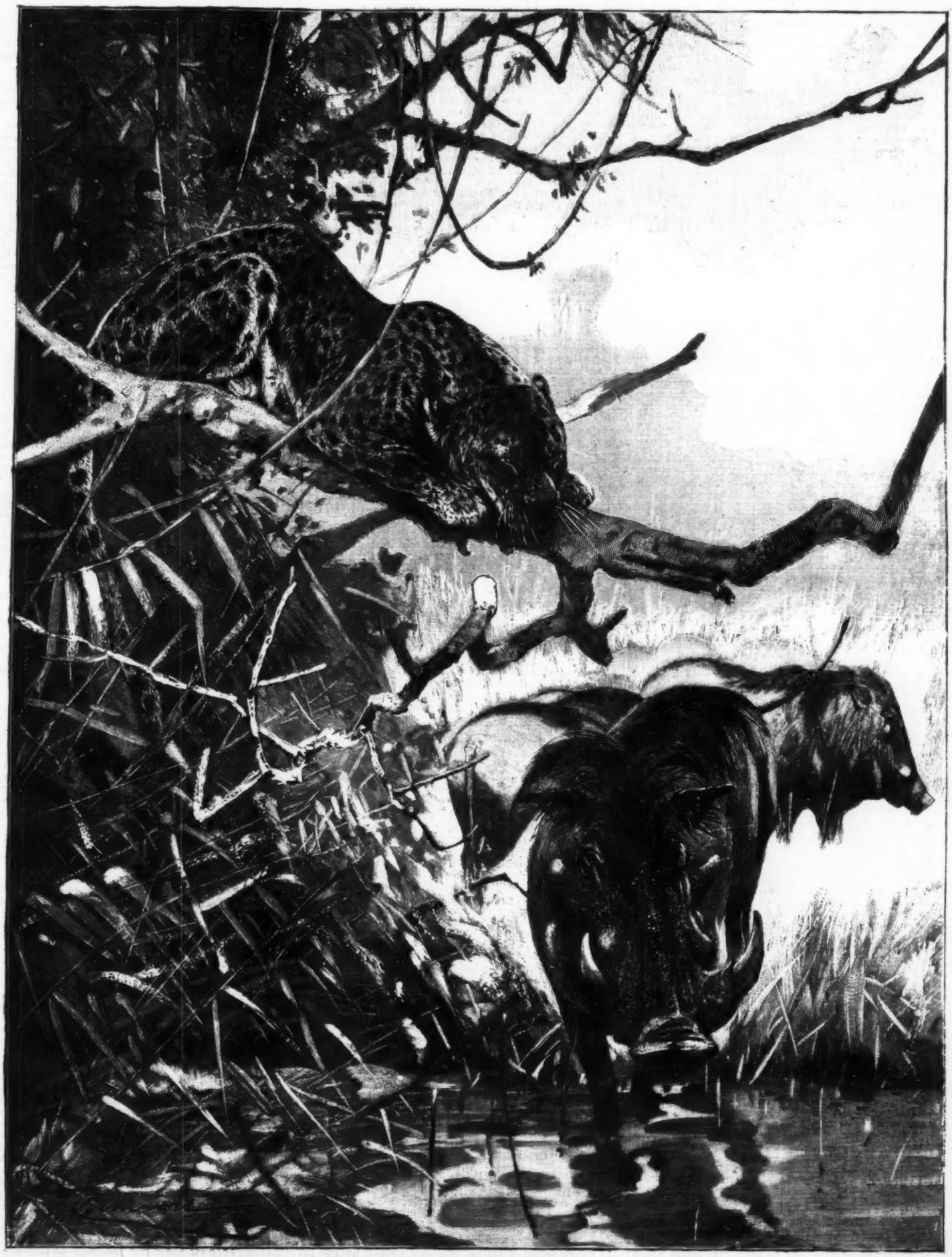
WART HOG SURPRISED BY A LEOPARD.

THE wild swine of the forest certainly cannot make any claim to beauty, but his near relative the wart hog (Phacochoerus aethiopus Pallas), of Africa, is even uglier. Great tusks, which are most dangerous to hunters, project outward and upward from both sides of his head, and between those and his eyes his face is disfigured by wartlike growths of flesh which certainly do not make him more attractive. These hogs live in small herds or singly in swampy regions. They are said to be very fierce and strong, but, in spite of this, are quite helpless when attacked by their bitterest enemies, the leopards. A leopard will crouch on a branch of a tree over a place that is frequented by these hogs, and when they appear will chose his victim and jump on his back, fixing his teeth in the nape of his neck. Neither his sight nor his sense of smell can be very good to allow him to approach so close to his enemy, but his hearing, which is supposed to be very acute, cannot help him in this instance, for the leopard will lie motionless for a long time waiting for his prey.—Für Alle Welt.

EXPERIMENTS ON ANIMAL INTELLIGENCE.

THE intelligence of animals has long been the subject of observation, but it has remained for our generation to put it to the test of experiment—such experiment as may now be carried on in the laboratories devoted to the "new psychology." A series of such experiments, described by Edward Thorndike in Science (June 17), has just been completed by him at Columbia University, and shows, if we agree with the author's views, that the animals experimented upon (dogs, cats, and chickens) do not reason, in the same sense in which men may be said to reason, and have no true memory. True reasoning begins, he thinks, with the primates (monkeys, etc.) The enthusiastic dog-lover who is tempted to disagree with Mr. Thorndike should read his argument carefully and understand his definitions of "reason" and "memory" before coming to an adverse conclusion. We have room here for only part of the discussion. Says Mr. Thorndike:

"The experiments were upon the intelligent acts and habits of a considerable number of dogs, cats, and chicks. The method was to put the animals when hungry in inclosures from which they could escape (and so obtain food) by operating some simple mechanism, e. g., by turning a wooden button that held the door, pulling a loop attached to the bolt, or pressing



WART HOG SURPRISED BY A LEOPARD.

down a lever. Thus one readily sees what sort of things the animals can learn to do and just how they learn to do them. Not only were the actions of the animals in effecting escape observed, but also in every case an accurate record was kept of the times taken to escape in the successive trials. The first time that a cat is put into such an inclosure, some minutes generally elapse before its instinctive struggles hit upon the proper movement, while after enough trials it will make the right movement immediately upon being put in the box."

Mr. Thorndike believes that the animal gets out the first time by accident, and is so pleased that the act is impressed on its mind. Thus, the second time, it will be likely to hit on the right way sooner, and so finally employs it as soon as imprisoned. He believes that the animals gave no signs of inference, comparison, or generalization, or perhaps even of reasoning at all, in the proper sense. He says regarding this:

"Surely if a cat made the movement from an inference that it would open the door, it ought, when again put in, to make the movement immediately. If its first success was due to an inference, all trials after the first should take a minimum time. And if there were any slightest rudiment of a reasoning faculty, even if no real power of inference, the cat ought at least some time, in the course of ten or twenty successful trials, to realize that turning that button means getting out, and thenceforth make the movement from a decision, not a mere impulse. There ought, that is, to be a sudden change from the long, irregular times of impulsive activity to a regular minimum time. The change is as a fact very gradual.

"Finally, experiments made in another connection show that these animals could not learn to perform even the simplest acts by seeing another do them or by being put through them by the experimenter."

This leads to an interesting result. Mr. Thorndike's experiments show, he says, that cats and dogs do not imitate. Monkeys undoubtedly do. If this is so, "we have located," he says, "a definite step in the evolution of mind." The "association of ideas" is quite different in the cases of animals and man. A man in a room will go and open the door if he wishes to get out, the thought of the outside of the room naturally suggesting this act. But a cat will not crawl into a box where there is something to eat unless she has been trained to crawl in before; if she has been dropped in, she will not think of crawling in. That is, in man's association, thoughts are essential factors; in that of animals they are only sense-impressions and impulses to act. In short, these animal acts are learned as a man learns to play a game of skill like billiards. A man cannot reason himself into being a good billiard player; nothing but practice will do it. The apparently intelligent acts of the animals on which Mr. Thorndike experimented were, in the same way, the result of practice by repetition—not of true reasoning. Neither do animals in such cases have true memory. He says:

"In the case of genuine memory you either know a thing and do it or forget it utterly and fail to do it at all. So with a man recalling the combination to a safe, for instance. But the memory of the animal is only that of a billiard player who hasn't played for a long interval and who gradually recovers his skill. No billiard player keeps thinking, 'Two years ago I hit a ball placed like this in such and such a way.' And the cat or dog does not think, 'When I was in this box before, I got out by pulling that string.' Not only the gradual recovery of skill, but also the actions of the animal, show this. In case of an association only partially permanent the animal claws around the vital spot, or claws feebly and intermittently, or varies its attacks on the loop, or what not, by instinctive bitings and squeezings. Memory in animals is permanence of associations, not conscious realization that a certain event or sequence occurred in the past."

The writer believes that very important results may follow from these and similar experiments. He says:

"The general view which the entire investigation has forced upon me is that animals do not think about things at all, that consciousness is for them always consciousness in its first intention, 'pure experience,' as Lloyd Morgan says. They feel all their sense impressions as we feel the sky and water and movements of our body when swimming. They see the thumb-latch as the ball player sees the ball speeding toward him. They depress the thumb-piece, not because they think about the act, but just because they feel like doing so. And so their mental life never gets beyond the limits of the least noticeable sort of human intellection. Conception, inference, judgment, memory, self-consciousness, social-consciousness, imagination, association, and perception, in the common acceptation of the terms, are all absent from the animal mind.'

In regard to our own mental development, Mr. Thorndike's experiments show the following facts, as he thinks:

"Our mental life has grown up as a mediation between stimulus and reaction. The old view of human consciousness is that it is built up out of elementary sensations, that very minute bits of consciousness come first and gradually get built up into the complex web. It looks for the beginnings of consciousness to little feelings. This our view abolishes, and declares that the progress is not from little and simple to big and complicated, but from direct connections to indirect connections in which a stock of isolated elements plays a part; is from 'pure experience' or undifferentiated feelings to discrimination, on the one hand, to generalizations, abstractions, on the other. If, as seems probable, the primates display a vast increase of associations, and a stock of free swimming ideas, our view gives to the line of descent a meaning which it never could have so long as the question was the vague one of more or less 'intelligence.' It will, I hope, when supported by an investigation of the mental life of the primates and of the period in child life when these directly practical associations become overgrown by a rapid luxuriance of free ideas, show us the real history of the origin of human faculty."

The first American locomotive for England has just been finished by the Baldwin Locomotive Works, says Engineering News. It is a double-ender, intended to run between Barnstaple and Lynton, the latter place being a sea resort about fifteen miles from Barnstaple.

TYPHOID FEVER IN PORTO RICO.

IN a recent issue of our esteemed contemporary The Medical News is an important article on "The Invasion of Porto Rico from a Medical Standpoint," by Nicholas Senn, M.D., Lieut.-Col. U. S. V., Chief of the Operating Staff with the Army in the Field. After giving an account of the engagements in Porto Rico, Dr. Senn touches upon the subject of typhoid fever in this island and writes as follows:

The native doctors in Ponce, Porto Rico, gave us the assurance that not a single case of yellow fever had been seen in that city for the last three years. We were informed that in San Juan isolated cases occur from time to time. Malaria is prevalent in all the valleys, more especially in and around Ponce. The large, pendulous abdomens and the pale faces of the many little naked children in city and country are the best witnesses in showing the prevalence of malarial intoxication. Typhoid fever is endemic in certain localities, but at present Ponce is almost free from this disease. Having seen the destruction of life and the indescribable suffering caused by yellow fever in Cuba, Col. Greenleaf naturally turned his attention toward protecting our troops in Porto Rico against this scourge. The proximity of Porto Rico to Cuba, and the many possible sources of infection, made such a course imperative. That this fear was not unfounded, and that the chief surgeon recognized the danger and made use of timely precautions, are best shown by the contents of a letter addressed to the Adjutant-General, Headquarters of the Army, and Circular No. 1 issued before the army sailed from Guantanamo to Porto Rico, and a copy of the quarantine regulations formulated at the same time.

Headquarters of the Army,
On Board the U. S. S. "Yale," en route to
Porto Rico, July 23, 1898.

To the Adjutant-General, Headquarters of the Army.

SIR: I have the honor to submit the following recommendations for the prevention, as far as possible, of the introduction of yellow fever into the command now about to land on the island of Porto Rico:

The assignment of an officer of rank, to be placed in command of the base of supplies, with authority to indicate the sites to be occupied by the various supply depots and the hospital, and to enforce the regulations governing the health of the attachés of these departments and the persons who may visit them on business.

The assignment of a sanitary inspector whose duty it shall be to examine all vessels and persons arriving at our base from seaward ports, and to prepare sanitary regulations for the government of all transportation and persons arriving and departing from stations by land. The officer should have authority to quarantine all suspected persons and means of transportation, and to disinfect their belongings either by fire or by such other means as may be deemed necessary.

All persons connected with the army are forbidden to enter any building whatever on the island without express authority from these headquarters, and all buildings in rural districts that may be suspected of harboring the germs of disease should be destroyed by fire or otherwise disinfected.

As woven goods, particularly those of woolen fabric, are special carriers of disease, the purchase or acceptance of articles of this kind from stores or inhabitants of the island is strictly forbidden. Any such property found within the lines will be at once destroyed and the holder subject to punishment.

That the commanders of regiments be instructed to prepare their camping grounds with great care and maintain a rigid police in them; under no circumstances shall they camp on ground that has previously been occupied either by troops or collective bodies of the inhabitants.

That medical officers be required to make frequent inspections of the commands to which they belong, and that any suspicious case of fever be immediately isolated and the fact of its occurrence reported to these headquarters.

Canteens should be filled daily with tea or coffee, and these beverages used habitually instead of water, unless that has been previously boiled.

Very respectfully,
CHARLES R. GREENLEAF,
Colonel, Assistant Surgeon-General, U. S. A., Chief Surgeon, Army in the Field.

Headquarters of the Army, Office of the Chief Surgeon, On Board U. S. S. "Yale," en route to Porto Rico, July 24, 1898.

Circular No. 1.

1. Medical officers will, upon receipt of this circular, report to the chief surgeon of the army the number of medical officers, hospital stewards, acting hospital stewards, and privates of the hospital corps on duty with their command. Also the number of ambulances, litters, and tents, and if medical supplies are insufficient, note the general character needed. This report will be made on the inclosed form.

2. A field hospital will be organized at the army base as soon as possible after landing, and a depot of supplies will be connected with it. As we are widely separated from our source of supplies, a strict economy in their use is necessary; surgeons of divisions and brigades will give their personal attention to this important subject.

3. Extreme vigilance is enjoined upon medical officers in the matter of camp sanitation, errors in this particular being promptly reported to the respective commanding officers.

4. The experience at Santiago has demonstrated the efficiency of properly applied first dressings in gunshot wounds; these should be left untouched until the patient arrives at the base hospital, unless the condition of the wound absolutely demands a redressing en route from the first-dressing station. All diagnosis tags will be marked "Dressing not to be removed," or "Redressing required," as the condition demands. Unless an imperative necessity exists, surgical operation will not be attempted at the front. CHAS. R. GREENLEAF,
Colonel, Assistant Surgeon-General, U. S. A., Chief Surgeon, Army in the Field.

QUARANTINE REGULATIONS FOR THE BASE OF MILITARY EXPEDITION TO PORTO RICO.

1. Every vessel shall be officially visited by the inspector before communication is made with other vessels or the shore.

2. A vessel having yellow fever or smallpox on board shall not be allowed to communicate with the shore, or with other vessels, but shall leave the island.

3. Vessels coming from sources of infection shall be detained five days without communicating either with the shore or with other vessels. If at the expiration of this time no cases of fever shall have developed, landing may be made under the following precautions:

All fomites shall be disinfected by one of the following methods: Immersion for one hour in 1-1,000 solution of bichloride; sulphur fumigation in a chamber twenty-four hours, 4 pounds of sulphur being used for each 1,000 cubic feet of space, or boiling half an hour with complete immersion. The following need not be disinfected unless directly exposed to infection:

All new and dry material unpacked, all iron and steel implements, all goods in new and original packages not having been broken or packed in an infected locality. Goods other than textile contained in textile material, such as coffee in sacks, bacons, spices, etc., kept dry, and not broken in an infected locality, do not require disinfection other than the container, which shall be treated as fomites as above. Fruits, sound, unless exposed in an infected locality, need no disinfection. Live stock may be admitted.

Such ships shall be thoroughly cleansed and disinfected by the free use of 1-1,000 solution of bichloride, and by fumigation with sulphur before they may again receive men or supplies.

Ships quarantined shall display the usual flag, and those in detention shall be visited by the inspector daily until the time of quarantine shall have expired.

4. Vessels carrying passengers or having fomites from localities of infection, though they (the vessels) may hail from healthy ports, shall be subject to the same quarantine restrictions as vessels known to hail from infected localities.

5. Due precaution shall be taken to prevent infection of the base of supplies through communicating with infected localities along the line of march, by teamsters and others. As far as possible they should not be allowed to remain at the base longer than necessary to load and unload, nor to come in such contact as to communicate infection. Stragglers, prisoners, and strangers should be immediately sent away.

CHARLES R. GREENLEAF,
Colonel, Assistant Surgeon-General United States Army; Chief Surgeon, Army in the Field.

Major Woodbury was appointed sanitary inspector. He met with the hearty co-operation of the city authorities of Ponce in the performance of his onerous and often unpleasant duties. The sanitary condition of the city underwent a great improvement in a few days. The water supply was found satisfactory. The absence of a sewerage system threw many obstacles in the way. The appearance of smallpox in a village some distance from Ponce made vaccination necessary among the soldiers and natives who were not protected against the disease. An abundant supply of vaccine virus was on hand, and was at once issued and used. When I arrived at Ponce, August 7, I found typhoid fever raging to an alarming extent. It was desirable to trace the origin of the disease. The absence of typhoid fever during this season of the year, its outbreak in all the commands, and the short time that had intervened between leaving the United States and the landing in Porto Rico, made it probable that the disease could be traced to the infected camps occupied by the troops before leaving for Porto Rico. Gen. Miles was very anxious to obtain reliable information regarding the origin and spread of this disease. Pursuant to the following order, I made an extensive and systematic investigation:

Headquarters of the Army,
Office of Chief Surgeon, Port Ponce, Porto Rico,
August 11, 1898.

Lieut.-Col. Nicholas Senn, Surgeon, U. S. V., Chief of Operating Staff of the Army.

SIR: You will proceed to the town of Ponce, visit the military and other hospitals of that town, and such of the camps in its vicinity as you may deem necessary, for the purpose of investigating and, if possible, determining the cause of typhoid and other fevers now prevailing in the army, and report the result of your investigation in writing to me. Should you find it necessary to have the services of an interpreter or other civilian to aid in your work, you are hereby authorized to employ him, sending the bill to this office for payment.

Very respectfully,
CHARLES R. GREENLEAF,
Colonel, Assistant Surgeon-General, U. S. A., Chief Surgeon, Army in the Field.

I obtained accurate information of two hundred fever patients, of which number 90 per cent. were well marked typhoid fever, the balance malaria and the result of sunstroke. I estimated the number of fever patients in Ponce and in the immediate vicinity at 250. In extending my inquiries to General Brooke's command, with headquarters at Guayama, I found about 145 additional cases; however, in that locality malaria seemed to predominate. Most of the patients came from Chickamauga by way of Charleston and Newport News. The Second and Third Wisconsin Regiments furnished the largest contingent. Almost every soldier in the different hospitals belonging to either of these regiments suffered from typical typhoid fever, and what attracted my attention was that the disease appeared to be of a more serious type than in most of the men belonging to other regiments. The locality from which these regiments came, when encamped at Chickamauga, must have been badly infected.

As the result of my investigation, I reported to Colonel Greenleaf the number of cases found, and that in my opinion the disease was contracted in every instance before leaving the camps in the United States. In view of the fact that most of the cases came from Chickamauga, I suggested at the same time that the Medical Department should recommend immediate evacuation of that camp. In Ponce most of the patients found shelter and care in the Spanish Military Hospital, then in charge of Major Ten Eyck, U. S. A. The Club House and a school for girls of the Sisters of Charity were also placed at the disposal of the chief surgeon and were soon filled with patients. Miss Chanler, of New York, did excellent service as a nurse in the former temporary hospital. A congestion which occurred in the Military Hospital, and which could

not be prevented, took place when General Wilson's Division moved forward and unloaded at the door all of the sick in the Division Hospital, some 150 in number. The overcrowded condition was remedied the next day when a large number of the more gravely ill were sent on board the "Relief," anchored in the harbor of Ponce. Medical supplies were in abundance at all times and were freely issued without any formality. The "Relief," and later the yacht "May," brought an abundant supply, with many delicacies for the sick. Milk was bought and freely supplied to the sick. It was the intention of the chief surgeon to establish an extensive outdoor receiving hospital as soon as the tentage arrives, which, according to information received from the Surgeon-General, was then on the way. The number of new cases of typhoid fever in the Porto Rican army will probably be a limited one, as the victims of this disease were immediately separated from their comrades, and if the troops are recalled as soon as the treaty of peace has been signed, we need entertain little fear of the indigenous spread of the disease.

THE DEVELOPMENT OF PHOTOGRAPHY IN ASTRONOMY.*

THE American Association for the Advancement of Science has now completed an existence of half a century. It has become one of the leading scientific institutions of this country. Since its organization, fifty years ago, the world has advanced with wonderful rapidity in all directions, and especially in the various fields of science. It is hardly too much to say that the scientific progress of the last half century far exceeds all that was done in the preceding thousand years. The life of this association practically covers the development and comparative perfection of many of the sciences. This is especially true of the wonderful art of photography. At the beginning of the work of this association the great discovery of making pictures by the natural light of the sun had just been made, and while it aroused a widespread interest all over the world at that time, there were very few who dreamed of the great future value of photography in the arts and sciences. One of these who saw something of the future of Daguerre's discovery was the celebrated Scottish astronomer, Dr. Dick, whose works on popular astronomy are still useful and delightful reading. In his "Practical Astronomer," published in 18.., he said:

"It is not improbable, likewise, that this art (still in its infancy), when it approximates to perfection, may enable us to take representations of the sublime objects of the heavens. The sun affords sufficient light for this purpose, and there appears no insurmountable obstacle in taking, in this way, a highly magnified picture of that luminary which shall be capable of being again magnified by a powerful microscope. It is by no means improbable, from experiments that have hitherto been made, that one may obtain an accurate delineation of the lunar world from the moon herself. The plated disks prepared by Daguerre receive impressions from the action of the lunar rays to such an extent as permits the hope that photographic charts of the moon may soon be obtained; and, if so, they will excel in accuracy all the delineations of this orb that have hitherto been obtained; and, if they should bear a microscopic power, objects may be perceived on the lunar surface which have hitherto been invisible. Nor is it impossible that the planets Venus, Mars, Jupiter, and Saturn may be delineated in this way, and objects discovered which cannot be descried by means of the telescope. It might, perhaps, be considered as beyond the bounds of probability to expect that very distant nebulæ might thus be fixed, and a delineation of these objects produced which shall be capable of being magnified by microscopes; but we ought to consider that the art is yet in its infancy, that plates of a more delicate nature than those hitherto used may yet be prepared and other properties of light may yet be discovered which shall facilitate such designs."

Had Dr. Dick lived until the present day, he would be amazed to see what portions of his prediction have, in a measure, come true. To him the most improbable of the things he forecast for photography to accomplish was the delination of the nebulæ, and yet it is in this direction that photographic astronomy has most decidedly excelled. To use highly magnified images for photographing the details of the planets seemed to him to be among the first triumphs that were to fall to astronomical photography; yet to-day they are almost as far from realization as they were in the days when good Dr. Dick charmed his readers with vivid descriptions of the wonders of astronomy. I do not think the most active imagination could have foreseen in Dr. Dick's day the marvelous extent to which astronomy, at the close of the nineteenth century, would be influenced by that light-picturing process just then being developed by Daguerre and others.

After all, however, it is easy in the case of great discoveries of this kind to predict what they will amount to. This is usually done by immensely exaggerating all their possibilities and thus, by a happy chance, hitting one or more of their realities, for strict account is usually kept only of the hits in such cases, the misses being rejected by a charitable world as a matter of no importance. We are used to wonders in these days of wonders, and we have a happy habit—from frequent practice—of correctly guessing the outcome of some of the great discoveries. But when Dr. Dick wrote, these things were not so easily foreseen, for the possibilities of the sciences were not so apparent then as they are now.

No great have become the possibilities of photography in the astronomical investigations of to-day that an account in detail of its accomplishments would far exceed the limits of this paper, and for that reason I shall be forced to a brevity in dealing with this subject that must necessarily pass over many of the interesting things photography has done for astronomy in its comparatively short lifetime.

It does not come within the province of a paper of this kind to deal with the questions of priority in the discovery of photography (though something might be said on that point for America), as the process interests us only so far as its application to astronomy is concerned.

It appears that on the very first announcement of Daguerre's wonderful discovery, on the 19th of August, 1839, the celebrated French astronomer, Arago, who addressed the Paris Academy on the subject, quickly foresaw the great advantage it must necessarily be to the science of astronomy, especially in the faithful delineation of the surface features of the sun and the moon, for these two objects at least were bright enough to register themselves with the sluggish materials then in use. It is specially gratifying to Americans that the first efforts to utilize the new discovery for the benefit of astronomy were made in this country and that Americans have always been prominently identified with the process from its very earliest conception.

Within less than one year from the announcement of Daguerre's discovery, in March of 1840, Dr. John W. Draper, of New York city, had succeeded in getting pictures of the moon which, though not very good, foreshadowed the possibilities of lunar photography. Five years later the Harvard College observatory may be said to have commenced its remarkable career of astronomical photography, when Bond, with the aid of Messrs. Whipple and Black, of Boston, succeeded in getting still better pictures of the moon with the 15-inch refractor. These pictures, on daguerreotype plates, seem to have been fairly good, and to have shown much detail, though the telescope was wholly uncorrected for the photographic rays. They attracted a very great interest in the subject, especially in England, but the difficulties encountered led to the failures generally, except in the case of De la Rue, Dancer, and one or two others. To Dancer is doubtless due the earliest success in lunar photography. Excellent photographs, it is said, were made by him as early as February, 1850. In 1858 De la Rue, using a 13-inch metal speculum, without clockwork, and guiding by following a lunar crater seen through the plate, made the most important of the early efforts at lunar photography. From this time De la Rue made the best pictures of the moon until the subject was taken up again in America, in 1860, by Dr. Henry Draper, son of the illustrious John W. Draper. Like De la Rue, Dr. Draper constructed his own telescope, a 15½-inch reflector. With this instrument he secured excellent photographs of the moon, superior to any previously made, and capable of considerable enlargement. These pictures were the best taken until Lewis M. Rutherfurd began his remarkable work about 1865. Rutherfurd's work marked the most important step until then made in astronomical photography. From this time on he produced such admirable photographs of the moon that they have not been excelled until within the past few years. These were made with a refractor of 11-inch aperture, which had been constructed under his immediate supervision. It was the first telescope corrected specially for the photographic rays. Some excellent lunar photographs, in the meantime, had been made with the great four-foot reflector of the Melbourne observatory.

The completion of the Lick observatory, in 1888, marked another decided advance in the photography of the moon. The great focal length of this magnificent instrument gave an unenlarged image of the moon about six inches in diameter, which in itself was a great advantage.

The admirable lunar photographs made by MM. Loewy and Puiseux, with the equatorial coudé, at Paris, in the past few years have excelled anything yet made in this direction.

But what is shown by the best lunar photographs has not yet approached that which can be seen with a good telescope of very moderate size. The minute details are at present beyond the reach of photography, but its accurate location of the less difficult features is of the highest value. The greatest interest in any observation of the moon would be in any changes that might take place on its surface. It has long ago been shown that no changes on a large scale have occurred in recent times. It is, therefore, to the minuter details, if anywhere, that we must look for change in the moon, and these at present are much beyond the reach of the photographic plate.

The sun, from its abundance of light, offered special inducements to the early workers in photography. It would rather appear, however, that the moon had the most charm for the first photographic astronomers. This was doubtless due to the singular and wonderful wealth of detail its surface continually presented, while the sun, except for a few occasional spots, was at best only a blank surface. But when carefully and conscientiously studied, however, it highly rewarded those who took up its study photographically.

The first picture of the sun seems to have been made on a daguerreotype plate by Fizeau and Foucault in 1845. During the total eclipse of the sun on July 28, 1851, a daguerreotype was secured with the Königsberg heliometer (2·4 inches in diameter and 2 feet focus) by Dr. Busch, which appears to have been the first photographic representation of the corona. It showed considerable detail quite close to the moon. But in the early eclipses the photographic work seems to have been mainly devoted to representations of the solar prominences, which at that time were as rarely seen as the corona itself. During the eclipse of 1869, however, Prof. Himes secured a photograph which showed the brighter structure of the corona; similar pictures were also obtained during the same eclipse by Mr. Whipple, of Boston. The corona was also slightly shown on pictures made as early as 1860 by M. Serrat. None of them, however, showed more than slight traces of the corona, extending only for a few minutes of arc from the moon's limb. Nearly all the pictures seem to have been taken with an enlarging lens, which was doubtless used to get the prominences on a larger scale. Mr. Whipple, however, in 1869, did not use any primary enlargement, and this gave him a decided advantage in point of exposure time. In nearly all of these pictures the exposures, with the slowness of the then existing plates, were evidently too short to show the corona, except perhaps in the case of Whipple, who gave 40 seconds exposure.

The first really successful photographs of the corona were obtained at the eclipse of December 22, 1870, when it was shown on the plate to a distance of about half a degree from the moon's limb. This picture, made by Mr. Brothers at Syracuse, Sicily, showed a considerable amount of rich detail in the coronal structure; and the same can also be said of the photographs of this eclipse taken by Colonel Tennant and Lord Lindsay's party. These seem to have been the first pictures to really show the great value of photography for coronal delineation. The eclipse of 1871 was still more successfully photographed, and an excellent representation of the corona, full of beautiful detail, was secured.

All of these pictures were made with the wet process, for the dry plate was not successfully used until about 1876, and it was five or six years later before it became generally useful or at all reliable. For some years previous to this, photographers had been at work with varied success upon different methods of preparing and sensitizing plates that could be used dry. Indeed, at the eclipse of 1871, at Baikul, India, it appears that Mr. Cherry used a dry plate on which he exposed a number of images of the sun before totality for the orientation of the eclipse plates. It would seem that he had only two of these plates and they were both intended to be used for orientation. The second plate, however, was broken before it could be used. It is probable they were known to be less sensitive than the wet plates, which doubtless prevented their being used for the corona.

Though the pictures of 1870 and 1871 showed the value of the photographic method, it had so far failed to show the greater and fainter extensions of the corona. In speaking of the eclipse of 1871, and the success attained by photography at that time, it is well here to mention the evil influence that the old method of drawing had upon at least one observer. A Mr. Holiday had made observations of the corona from a housetop, and thus describes the result in his report: "As soon as the eclipse was over, I came down from the roof and plunged my head into cold water, for I was violently excited, and before breakfast I had made three drawings from my memoranda." If photography has done nothing more for astronomy than to prevent occurrences of this kind, it would at least deserve lasting respect from a humane point of view.

In 1878 extensive preparations were made to observe the eclipse of July 29 of that year. Photography was to play an important part, though astronomers did not rely very strongly upon it, for it appears that all were prepared to make the customary drawings of the corona, and unfortunately each person faithfully carried out that purpose. A most suggestive illustration of the uncertainty of such work is found in the large collection of drawings published in a volume issued by the United States government relating to the eclipse of 1878. An examination of these forty or fifty pictures shows that scarcely any two of them would be supposed to represent the same object, and none of them at all closely resembled the photographs. The method of free-hand drawing of the corona made under the attending conditions of a total eclipse received its death blow at that time, for it showed the utter inability of the average astronomer to sketch or draw under such circumstances what we really saw.

At this time the dry plate was still in its infancy, and the results with it ranged from failure up to a fair picture of the corona. The greatest extension of the corona obtained, however, seemed to be about half a degree from the moon's limb, while Profs. Newcomb and Langley traced it nearly six degrees with the eye alone. The results, nevertheless, were highly important, and they demonstrated the success of photography for this class of work. One of the cameras at this eclipse was put in charge of a private soldier, with instructions to give an exposure of sixty-five seconds. The instructions were faithfully carried out, but as no one had told him to draw the dark slide, the plate remained unexposed.

The total eclipse of 1882 proved to be of special interest, from the fact that a small unknown comet was then in the immediate neighborhood of the sun, and was seen with the naked eye during the eclipse. The increased sensitiveness of the plates then in use secured a strong impression of this object. The known history of the comet is comprised within the few minutes of totality of that eclipse, for it was never seen afterward.

In the eclipse of 1886 photography again held an important position. But the extremely humid climate of Granada (one of the observing stations) and the necessity of employing volunteer observers led to numerous disasters, such as the failure to get the sun's image on the sensitive plate in the most important instrument; the breaking of the polar axis just before totality in the next important instrument; the failure of an assistant to make the exposures with another until totality was all but over; the fact that two native policemen stood in front of the photometer during totality; the two weeks' delay of the steamer in getting away from the island; the seizure of the plates by the custom officials on arrival at New York, and, after their rescue, the subsequent delay for want of time to develop the plates, until May of next year, when they had undergone decomposition, so that the results were not as good as might have been expected.

The closing of the year 1888 and the opening of 1889 brought one of the most important eclipses that had yet occurred from a photographic standpoint. Certainly no previous eclipse, nor any since, so far as that is concerned, was photographed by so many persons, and with such a varied assortment of cameras, telescopes, etc. The path of this eclipse lay across Nevada and California, and every photographer, amateur or professional, near the line of totality took part in the work. The amateur photographers of San Francisco and Oakland banded together under the leadership of Mr. Charles Burckhalter and photographed the eclipse in a systematic manner, the result being a most excellent collection of negatives of the corona. In some of these pictures the coronal streamers were carried to a far greater extent than at any previous eclipse; especially was this so in the photographs made by two of the amateur photographers, Messrs. Lowden and Ireland. At this eclipse the lot fell to the writer to make the photographs for the Lick observatory. But at this time the observatory had no instruments suitable for the work. To secure as large an image as possible with the poor equipment at hand, a 3¼-inch visual objective by Alvan Clark was selected. This lens, after being reduced to 1¾ inches in diameter and mounted in an oblong box fastened to a polar axis driven by the clockwork belonging to the 12 inch equatorial, was found to give a fairly good photographic image. With this and two small photographic cameras, nine nega-

* Address of Prof. E. E. Barnard, Vice-President, before Section A—Mathematics and Astronomy—of the American Association for the Advancement of Science, August 22, 1898.

tives of the corona were secured. The best of these was one made with the Clark visual objective. By extreme care in development, this negative not only showed the exquisite polar systems of streamers and the details of the corona close to the moon, but also carried the coronal extensions a great distance along the ecliptic. This was by far the most successful eclipse, photographically, of any that had yet been observed, and forever set aside as worthless the crude and wholly unreliable free hand sketches and drawings previously depended upon.

The eclipse of December 21, 1889, was successfully photographed, among others, by Mr. Burnham and Prof. Schaeberle, comprising the Lick observatory eclipse expedition which was sent to Cayenne. It was at this eclipse that Father Perry lost his life through the trying climatic conditions. With the sickness of death upon him, this brave man, fearless in his duty, stood by his cameras and carefully carried out his programme during the eclipse, only to collapse at its close and die a few days later on the vessel that was carrying him away from the fateful spot.

The eclipse of 1893 was successfully photographed in Brazil, Africa, and Chile. Prof. Schaeberle made arrangements for the photography of the corona on a large scale, and with his apparatus at Mina Bronces, Chile, secured a fine series of photographs with a photoheliograph of 40 feet focus, which he mounted on a hill sloping toward the sun. The image was formed by a stationary lens 5 inches in diameter upon a large sensitive plate which was moved by clockwork to counteract the sun's motion during the few minutes of the eclipse. In these pictures the image of the sun was on such a large scale that the coronal details could be very accurately studied. Upon these plates Prof. Schaeberle found a hazy ill-defined spot at forty minutes' distance from the sun's center. This he subsequently found on the African and Brazilian plates, taken by the English and American astronomers. This object was in motion away from the sun, as shown by the photographs, which covered an interval of 2 hours and 36 minutes of absolute time. Prof. Schaeberle believes this was a comet. It is not impossible, however, that it was a mass of coronal matter moving out from the sun, such as has been shown by the spectroscope frequently to occur in the case of solar prominences. The fact that the object seemed to be connected with the sun by a coronal streamer would rather favor the explanation. The drawing given in Astronomy and Astro-Physics, p. 307, vol. xiii., seems to further support this idea.

During the solar eclipse of 1896 the sky was cloudy at nearly all the stations, and especially where the most elaborate preparations had been made for photographic work. A few photographs were obtained, however, some of which, with very small lenses, showed the coronal extensions to a great length. The most important photographic work at this eclipse was the photographing of the flash spectrum, or the momentary reversal of the Fraunhofer lines, which occurs when the edge of the sun disappears behind the moon or reappears from it, and for an instant exposes the reversing layer, which was first seen by Prof. Young, at the eclipse of 1870. This extremely important picture was made by William Shackelton, a young Englishman, who patiently waited and watched the spectrum at the edge of the sun, and at the instant of the reversal of the lines exposed a plate which caught, for the first time, the fugitive bright lines which are only visible for about a second. This photograph was a triumph for photography, for the record of the phenomenon now does not rest upon the authority of any hasty observations, but remains a permanently visible record.

Our record closes with the eclipse of January 22, 1898, which was photographed in India by American and English astronomers. The photograph of the flash spectrum was successfully repeated by many observers. The coronal extensions were carried to a greater extent than at any previous eclipse, by photographs secured with a very small lens, by Mr. and Mrs. Maunder. The observations at all the stations were eminently satisfactory.

In speaking of the photography of the corona, it is well to mention the extremely interesting experiments of Dr. Huggins in an endeavor, some years ago, to photograph it without an eclipse. By the use of absorbing media, and later with extremely short exposures, he obtained very corona-like appearances, and it is not yet certain that they were not true coronal forms. Such experiments should be tried at very high altitudes in a pure atmosphere, and it is to be hoped that these efforts will be again undertaken under more favorable conditions.

The transit of Venus across the sun's disk in 1882 was very successfully photographed, and the measures of the pictures made by the Americans have given a good redetermination of the solar parallax. A fine series of photographs of this transit with wet plates was obtained by Prof. D. P. Todd at the Lick observatory. This was six years before the completion of the observatory.

There is no question but Janssen, of Meudon, succeeded many years ago in making the best photographs of portions of the sun's surface that have yet been made. These pictures show the granulation of the solar surface and the details of the sun spots with admirable clearness. Janssen has always used the old wet plate process, which seems to give the best results in solar work. The instrument with which his work is done is a very crude affair. The lens, 5 inches in diameter, is placed in a wooden box, which is mounted on an old camera stand on rollers. It is not provided with clockwork. When Janssen wishes to make a photograph of the sun he wheels this primitive affair, stained and daubed with nitrate of silver, from a shed onto a platform, elevates it toward the sun, makes an exposure with a rapidly moving slit, and secures a photograph which, so far, but few have approached in excellence. These pictures are enlarged by a secondary lens in the camera box to about twenty inches in diameter. One peculiar feature of these photographs is the frequent presence of blurred regions, in striking contrast to the generally exquisite sharpness of the granular surface.

These disturbed regions are believed by Janssen to be due to actual disturbances on the sun's surface, and, therefore, to be true phenomena of the sun. I have always had the impression that these features are simply due to the presence of small areas of bad seeing which are passing at the moment of exposure; that is, they are the effects of small local disturbances in our own air, such as every visual observer is familiar with in night work. I remember having once secured a photograph of the moon with the 12-inch of the Lick observatory which showed just such a blurred spot on its surface. This question could be easily settled with a few exposures made a minute or so apart, for if the blurred appearance repeats itself at the same point on the sun's disk, then it cannot be due to local atmospheric disturbances. Doubtless M. Janssen has long ago decided this question, but, if so, it has escaped my notice.

For the first successful photographs of the sun's surface, however, we must return to America. The first pictures to show this granulation and the details of the sun spots were taken by Lewis M. Rutherfurd in 1870.

These pictures were also made with the collodion or wet process.

(To be continued.)

BUDDLEIA VARIABILIS.

DR. HENRY was the first to discover this plant in the mountains north of Ychang. Mr. Hemsley was the first to describe it in the Journal of the Linnean Society. It was introduced into France in 1893, and exhibited for the first time at a meeting of the National Horticultural Society of France in 1894. On March 16, 1898, a colored figure was given in the Revue Horticole, together with a description from M. Maurice de Vilmorin. Later still, in the same year (August, 1898), it was figured in the Botanical Magazine, t. 7609. Specimens have been obligingly sent to us by Mr. Gumbleton and

BUDDLEIA VARIABILIS—FLOWERS LILAC, WITH A GOLDEN EYE.

Messrs. W. Paul & Son, of Waltham Cross. By the last named exhibitors the plant was exhibited before the Royal Horticultural Society, and obtained an award. It is unnecessary, in the face of so much description and illustration (see figure herewith), to say more than that it is (presumably) a hardy shrub, with much of the habit of B. Lindleyana, a species we have found to be hardy, unless in exceptionally severe winters, when even Buddleia globosa is killed to the ground near London. The leaves are shortly stalked, lanceolate, acuminate, finely serrulate, dark green, but covered with a thick white felted stellate down on the under surface, and with small ear-shaped interpetiolar, leafy stipules at the base. (See Masters on the "Foliation and Ramification of Buddleia auriculata, Journ. Linn. Soc., December 1, 1881.) The density of the inflorescence, its degree of branching, the more or less foliaceous nature and conspicuousness of the bracts, are all subject to variation, as is likewise the color of the flowers. Generally they may be described as more or less deeply lilac, with an orange throat; but as the specimen withers, they speedily become uniformly brown. M. de Vilmorin notes the variation in color, and so does Mr. Gumbleton, in a letter with which he has favored us, so that the term variabilis is well justified.—The Gardeners' Chronicle.

A new use has been found for fast torpedo boat destroyers. The 30 knot boat "Mallard" is under orders to keep cruising in the North Sea, for the purpose of training pigeons for the naval service.

HORSERADISH.*

THIS well known condiment† is prepared from the root of a plant that belongs to the same natural family as the cabbage, turnip, wallflower, stock, and many other vegetables and flowers, and to which also belong charlock, mustard, shepherd's purse, and several other noxious weeds.

The plant, which is a hardy perennial, is thought to have been naturalized in Great Britain from some more eastern European country. It is found growing wild in moist locations along the margins of streams, in cool, open woods, wet meadows, and other situations. From England it has been carried to many countries in the temperate zones, to be used for culinary purposes. It has, however, often made its escape from cultivation, and has sometimes, as in parts of the State of New York, become troublesome as a weed.

The roots are fleshy, whitish externally, and very white within; conical at the top, then cylindrical for several inches, not forming a taproot like a carrot or parsnip, but abruptly branched at the lower end, the more or less widely spreading branches slowly tapering below. The rootlets have been known to clog tile drains at a depth of seven feet. When bruised or scraped the root emits a strong, pungent odor; when eaten, it is hot and biting. These peculiarities are imparted to water and to alcohol, and are due to an essential oil, which is dissipated by drying, the root becoming at first sweetish and ultimately insipid and inert. The oil, obtained by distillation with water, is colorless or pale yellow, heavier than water, very volatile, excessively pungent, acrid, and corrosive, exciting inflammation and even vesication when applied to the skin. According to Gutret, only six parts of this oil, which Hubatka considers as identical with the essential oil of mustard, are obtained from 10,000 parts of the root.

"Horseradish," says the United States Dispensatory, "is highly stimulant, exciting the stomach when swallowed, and promoting the secretions, especially that of urine. Externally it is rubefacient. Its chief use is as a condiment to promote appetite and invigorate digestion; but it is also occasionally employed in medicine, particularly in dropsy attended with enfeebled digestion and general debility. It has, moreover, been recommended in palsy and chronic rheumatism, both as an internal and an external remedy, and in scorbutic affections is highly esteemed."

The consumption of horseradish as a table relish seems to be on the increase, and the cultivation of the crop is receiving more attention than formerly. Even under the common practice of planting a few roots and letting them shift for themselves the crop is found to be profitable. And under the improved methods of cultivation and of fertilization the returns have usually been highly satisfactory to the grower, provided no enemy attacked the plants. In the Washington market alone the average sale of the ground root is estimated by dealers to be 1,500 pounds a week during the season. To this must be added the quantity sold by hawkers on the streets and that disposed of by grocerymen, both bottled and evaporated, no accurate estimate of which can be obtained. The plant has, as yet, not been grown extensively in the South, but, according to Prof. P. H. Rolfs, of the Florida Agricultural College, seems worthy a trial for shipment to Northern markets, where it is most in demand.

The season for fresh grated horseradish is practically the same as the season for oysters, with which the root is most often eaten in the Atlantic States. Large quantities of the ungrated root are, however, kept in cold storage, and prepared during the warm months to be used with roast beef and other meats. Those roots are kept in preference to digging fresh roots during the growing season; first, because of the small size of the latter, and, second, on account of their inferior and sometimes even disagreeable flavor at that time.

Preparation and Uses. — Horseradish is a familiar condiment when grated and mixed with vinegar, for which use the fresher it is, the better. If exposed to heat and air, it will lose its peculiar pungency within an hour and will soon become insipid and inert. When grated for mixing with vinegar the combination should be made at once and the mixture hermetically sealed in pickle bottles or fruit jars. When used without vinegar, it should be grated immediately before being served, or should, if prepared earlier, be closely covered and set in a cool place. The grater usually seen in the markets is a wooden cylinder studded with steel pegs half an inch long. This forms a drum which is driven by a treadle.

Besides this common method of preparing the root, horseradish is prepared in several other ways, two of the best of which are here given.

Horseradish Sauce.—Cover one pound of sliced root with spirits of wine, 95 per cent. alcohol, and keep tightly corked. This is added drop by drop to any of the white sauces used for meats or fish, until the desired flavor is obtained. When mixed with a little fresh mustard and a little red pepper this tincture makes an excellent sauce for boiled beef or deviled chicken. On account of its volatile nature it should never be left uncorked, and should be added to the final sauce just before being served.

Horseradish Vinegar. — Soak a cupful of freshly grated root, together with an ounce of minced shallots or onions, one clove of garlic, and a pinch of red pepper, in a quart of cider vinegar. After being kept tightly corked for a week, strain the liquid through a cloth and bottle it for use. It makes a pleasant addition to many salads.

Horseradish as a Salad and a Pot Herb.—It is not generally known that a fine salad may be grown from horseradish in almost the same manner as barbe de capucin is grown from chicory roots. The horseradish roots are dug in late autumn and the crowns left intact. They are then buried standing upright in moist (not wet) earth, in a dark, warm cellar or underneath a greenhouse bench and the leaves forced as rapidly as possible. When these are about 3 or 4 inches long, they may be cut and used either singly or mixed with other plant salads. If darkness prevails during their growth, the leaves will be white and tender and will have a sweetish pungency, but if allowed to have light,

*Portion of Circular No. 15, United States Department of Agriculture, Division of Botany.

†Roripa armoracia (L) A. S. Hitchcock; Nasturtium armoracia (L) Fries.

they will be green and tough and too strong for use as a salad.

The leaves of the plant when grown in the garden are sometimes used as a pot herb, but they are not specially adapted for this purpose, since they are likely to be stringy and coarse unless very young. They have, moreover, a bitter taste, which is difficult to remove unless the water in which they are boiled is changed several times.

RECENT STUDY OF PREHISTORIC MAN IN EUROPE.

TWENTY-FIVE years ago the philologist had everything his own way in prehistoric research, says The Literary Digest. Max Müller and the school that he represented had analyzed the history of human language with such acumen that it was almost forgotten that it was possible to identify a race in any other way than by its speech. Of late, however, others have begun to be heard, and it is now widely recognized that the physical features of a race constitute a much safer means of identification, since language can be learned, while the physical features are transmissible only by heredity. Whole races have changed their language, but they could hardly change their facial outlines or the color of their eyes or hair. Owing to this change in standpoint, belief on the subject of the great Aryan migration has undergone considerable modification. Dr. Sergi, one of the latest writers on the subject, recognizes "racial" migrations and "linguistic" migrations, and, as will be seen by his map, these have not followed the same lines. We quote a few paragraphs from an article on this subject by John L. Myres in Science Progress (London, July). Speaking of the old idea that racial movements and relations can be determined solely by a study of their languages, Mr. Myres says:

"The argument from similarity of language to community of race is obviously a weak one, even when supported with secondary philological arguments from a certain community of religious ideas, mode of life, and type of civilization among the various Aryan-spreading clans before their presumed separation. It seems an obvious remark that a language can be learned, while physical structure cannot, and that, as the widely different races which now speak Aryan languages cannot be regarded as varieties which have developed since the 'migration,' some of them, at all events, must represent non-Aryan and pre-Aryan races who have acquired Aryan speech from the new-comers.

"The obvious reply to this objection—that, however the others may have acquired their languages, nevertheless some one of these distinct races must represent the original Aryan-speaking stock—only challenges the further questions: Which, then, is the Aryan stock? Which are the non-Aryan recipients of Aryan speech? It would be disproportionate here, and it is fortunately unnecessary, to discuss the numerous attempts which have been made to answer this question. For of all the physical types which compose the population of Europe in historical and modern times, every one, the Turk only excepted, has been claimed as representing the original Aryan stock, or at least as closely akin to it.

"We are therefore justified in putting all primarily philological hypotheses on one side; if only on the ground that none of them meet the more probable case, that the race with which Aryan speech originated may have been at all times few in numbers, and may further have been long since extinct, and consequently that all the Aryan-speaking races of historic times may have, at one time or another, learned Aryan speech, without acquiring more than the slightest tincture of Aryan blood. The ground is thus left open for a review of the whole question from a point of view primarily anthropological, and based in the first place on physical, namely morphological, criteria of natural kinship between the races to be examined."

After a statement of some of the tests that are applied in the study of races by the more modern school, Mr. Myres thus states their conclusion as regards the race represented in its greatest purity by the "brunette" type of Europe:

"A survey of the whole of the Mediterranean coastland leads to the conclusion that its earliest recognizable inhabitants and their descendants, who form the great mass of the present population, belong to a single closely connected group of races; that their earlier home is to be looked for in the formerly fertile interior of north Africa, and not improbably, as Dr. Sergi has indicated, in or near the upper valley of the Nile; and that the peninsula of south Europe and Asia Minor have been peopled thence along several district routes which mainly follow the course of the Pliocene land-bridges.

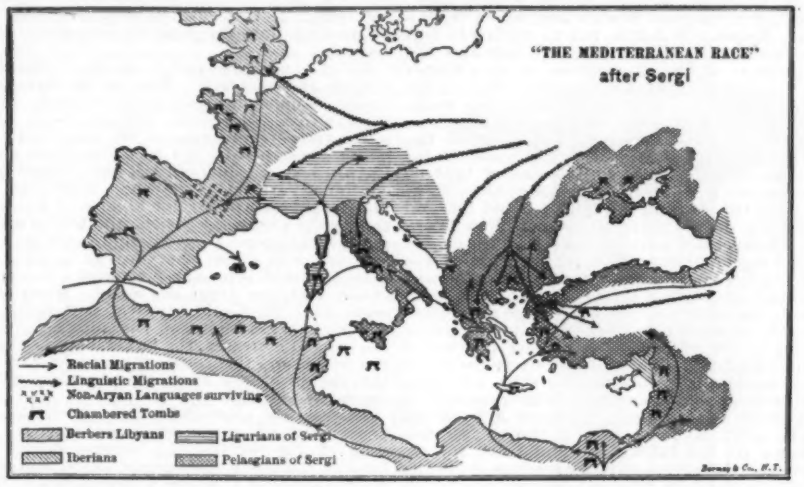
"The 'Mediterranean race,' thus described, has the following characteristics common to all its branches: The outer complexion is typically brown; brown skin, brown eyes, brown hair, abundant and always more or less wavy. It is thus equally distinct from the blond white races which bound it on the north and from the negro races of Africa. Modifications of the brown tint are found in all branches of the race; but are conceived to be due to intermixture either with yet earlier aborigines or with subsequent intruders. The body is well proportioned, the face oval, the nose rather narrow, the orbits wide and set horizontally, the forehead high and nearly vertical, the cheekbones neither wide nor very high; the face not flattened, but, if anything, a little prominent in front; the neck long and well rounded, and the features mobile and expressive. It is, in fact, the familiar brunette type which every one recognizes who has traveled in any part of the Mediterranean."

To determine the distribution of the race, Dr. Sergi has classified its members into morphological types depending on the form of the skull. Mr. Myres says of the method and of the conclusions that Dr. Sergi has drawn by its means:

"The method, in fact, is practically that of compound photography, and the principal types bear merely descriptive names such as elliptical, pentagonal, rhomboidal, or egg shaped; qualified by specific names, either descriptive, racial, or geographical. Determined by these tests, the Mediterranean race appears, wherever it is found, as a collocation, more or less uniformly complete, of a number of such related types; and from this it is inferred that the race was already composite in the farthest area of origin to which it can be traced.

"This center is placed in Dr. Sergi's map, and, as already indicated, in the upper valley of the Nile, on the ground that here among the Abyssinians, Gallas, and Somalis, the characteristic collocation of types is most completely exhibited; the dusky complexion of a large proportion of these races at the present day being discounted, partly by their long continued exposure to a more tropical climate than any other branch of the race; partly by the certainty of continuous infusion of a negroid strain from the south."

This probability of racial relationship between the northern African races and the negroes is most significant, especially when taken in connection with the belief that the darker members of the Mediterranean race in southern Europe, as in Spain and Sicily, are partly of Moorish or other north African descent. That the "Caucasian" brunette, who considers himself racially far above the lightest mulatto, should really owe his own dark complexion to his negroid affinities is somewhat startling, but no more so than thousands of other facts that science is daily putting beyond cavil.



THE FIRE DEPARTMENT OF THE CITY OF ROME.

IT was the duty of the triumvirs, from the oldest times of the Roman republic, to make the rounds at night in order to extinguish fires, or, at least, to make the existence thereof known to the watchmen at the gates and walls of the city. At this epoch there were also what we should call volunteer firemen. There were families that made it a business to put out fires, either for money or gratuitously; but as yet there was no special organization. In order to find this we must descend to Augustus, who in the year 759 of the founding of Rome (six years after Christ) instituted provisionally a corps which represented what are now our firemen. In view of the services that it was to render, he constituted this corps definitely, dividing it into seven cohorts, each having charge of two wards of the city, and uniting all these men under the command of a præfectus vigilum.

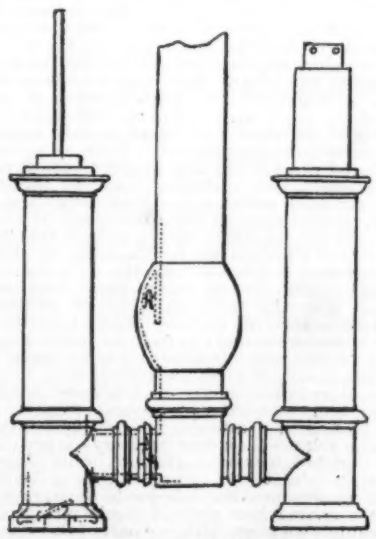


FIG. 1.—A ROMAN FIRE PUMP.

Rome at that time was the most populous city in the world, for the census showed that it had 1,340,000 inhabitants. So this institution had to be placed upon an extensive footing. Each cohort consisted of nearly a thousand men, and was divided into seven centuries. Under the commander in chief there was the subpræfectus, seven tribunes, each at the head of a cohort, forty-nine centurions, and a large number of principales, who, intermediate between the centurions and soldiers, would represent our present lieutenants. Each cohort was provided with four surgeons, nearly all Greeks. The other details of this organization of the vigiles, the Latin name by which the Roman firemen were called, we shall pass over. From various documents relating to it, we find that this corps was autonomous and provided with all the administrative paraphernalia necessary for its mission. Not only had it its inspectors, its treasurers, its keepers of records, its intendants, its trumpeters, etc., but even its a quæstionibus, or soldier whose business it was to catechise—a method of repression or examination much in vogue in those days. Among these different secondary employments, two have caused archæologists much speculation.

In a graffito of an excubitorium or watch house of the seventh cohort was read the word Sebacia. This Latin word, which means "grease," or, better, "lard," is explained by another one—Lucernas, "lamps." There was, therefore, a special employe whose duty it was to look after the lights, or especially to have always ready the torches or lanterns for lighting the path of the cohorts while running to a fire at night. Was it the effect of atavism that in 1809 the fire department of Rome had charge of the public lighting? On the 12th of August, 1814 Marquis Origo, the chief of this department, wrote: "The surveillance of the lighting of the city has always been an essential attribute of the firemen." The nineteenth century was thus connected with the first.

These graffiti gave still another name, which, despite the efforts of those learned in antiquity, has remained an enigma. Among the orders of the cohort, one gave the name of Emitularius. According to a German, it was this person's business to manufacture cushions and place them upon the ground to deaden the fall of those who, in order to escape the fire, jumped from their house into the street. This is quite possible, but it is merely a supposition.

It has been possible to find the exact location of the seventh cohort of firemen, and even the plan of one of its barracks has been found in a fragment of a plan of Rome belonging to the region where, as the inscription shows, was situated the first station of the vigiles—Statio Coh. I. Vigilum. It was between the churches of Saint Marcel and Douze Apôtres. It was very large, and must have accommodated a thousand men.

We must distinguish the barracks of the cohort from the various watch houses (or fire houses, as we should call them), which were scattered all over, and were called excubitoria. One of these has been discovered at the Transtevere, near the church of St. Chrysogonus. Entering this by a few steps, one had to the right and left of the entrance a bench running along the wall for the accommodation of the firemen. In the center of the atrium there was a hexagonal curb that covered a drain for the rain water. Opposite this there was a door decorated with Corinthian pillars and that opened upon a small apartment ornamented with paintings. On the other side there was a room divided into two halls that were continued by a sort of passageway in which there was a well. Opposite the entrance there was a cuniculo or subterranean conduit, of which the use is not known.

What gives importance to this discovery is the large number of graffiti found therein. All the walls are covered with them. Some are drawings and others framed inscriptions. The respect that the ancients had

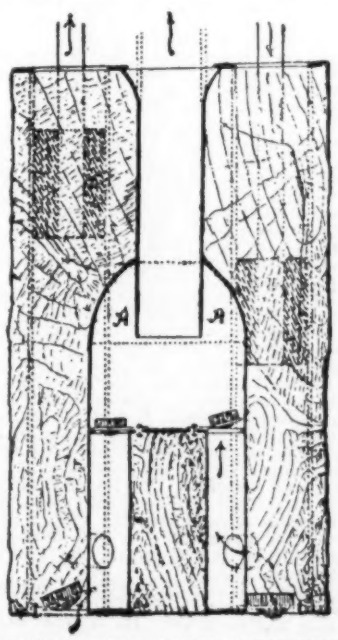


FIG. 2.—ROMAN FIRE PUMP DISCOVERED AT SILCHESTER, ENGLAND.

for such manifestations of thought is truly astonishing. As there was no press, each one wrote, if he knew how, upon the walls; and we cannot see that the latter were ever coated with new plaster in order to efface the preceding inscriptions. Now the walls of the exhibitorium under consideration are covered with graffiti, and it is precisely one of these that gives the name of Sebacia, whence that of Sebaciarius, which indicated a function hitherto unknown in the imperial fire department. Let us now see what apparatus the latter used for extinguishing fires. It had, in the first place, buckets called hamæ, which were heavy and consequently not easily handled, and were on this account often replaced by baskets of rushes closely woven and coated with pitch in order to render them watertight. It had, besides, machines called siphones. Ctesibius, who lived 250 years before Christ, invented for the raising of water a machine called antlia, which, upon the whole, was merely a force pump. From a description of it left by Vitruvius, this apparatus appears to have been in every respect similar to the pump employed in fire engines. It consisted essentially of two chambers which alternately forced water into a central conduit, in which it ascended; and even the chamber for rendering the jet regular under the influence of compressed air was not wanting.

Fig. 1 represents one of these pumps found near Civita Vecchia in 1795. Quite recently (in 1895) there was discovered in an ancient Roman city at Silchester, England, a pump that exhibits a curious peculiarity. It was carved out of a block of wood, probably oak. In this were bored out the two cylinders in which the pistons moved and the two conduits through which the water reached a central chamber, whence it flowed to the exterior. The conduits were lined with lead, which was itself held by the wooden walls, so that distortion through the pressure of the water was prevented. The central conduit had lost its lining of lead, but if the latter, when it existed, was slightly prolonged beneath the opening of the chamber, it must have formed at *AA* an annular space constituting a true compressed air chamber (Fig. 2).

This apparatus certainly had neither the fine aspect nor the power of those that we employ at the present day, but it was identical in its construction; and if mechanical processes had been more fully developed at that epoch, there is no doubt that the Roman models would have still more closely approached those now in use.

According to Pliny, the siphones were served directly by persons called aquarii, whose business it was to carry water to the cisterns in which the pumps operated. The latter were provided with pipes, either of wood or of leather, with metallic couplings, and it is probable that these were used (especially the leather ones) for carrying water under pressure to the place where it was needed.

There have likewise been discovered, and there may be found in the museums of Rome, a host of apparatus that were employed in the extinction of fire, and what is curious is that their form, fixed at the beginning, has scarcely varied, the firemen of the Rome of to-day still making use of apparatus that are almost exactly identical. They had pole ladders, double cramp hooks, axes, hammers, picks, etc., for use at fires, and there have even been found fragments of saws, belonging probably to the saw sword still in use in the Roman fire department. Finally there were certain individuals called centones, whose business it was to spread wet coverings over the neighboring houses in order to preserve them from fire.

The Romans, then, had a perfectly organized fire service, provided with all that was necessary to facilitate its task, and which might even to-day, in its general features, serve as a model for an analogous institution.—For the above particulars and for the illustrations we are indebted to Cosmos.

[Continued from SUPPLEMENT, No. 1186, page 19022.]

LIQUID AIR.*

Mr. CHARLES E. TRIPLER, of New York, N. Y., three years ago described to me a process for liquefying air by its own expansion. I was interested in the plan; and having seen Prof. Dewar's experiments, made up my mind that it was entirely possible to liquefy air by its own expansion as well as by the use of an auxiliary gas. Mr. Tripler worked out this process subsequently; so that, when I came back from Europe a year or so later, I learned that he was making liquid air by the bucketful. Indeed, so greatly had he improved and cheapened the operation, that while the liquid air contained in a little globe of 4 inches diameter is reported to have cost $500, when made by the process of Prof. Dewar, the five gallons in the can before you cost, as a matter of fact, only $20 at Mr. Tripler's laboratory. The Tripler process employs a 60 horse power engine and a triple compressor. The air is compressed in the first cylinder to 100 pounds per square inch; in the second cylinder to 800 pounds; and in the third cylinder to 2,000 pounds. This compression develops heat. The compressed air thus heated passes through pipes surrounded with water to reduce the temperature. It then passes through coils of copper tubes inclosed in a cylinder which is jacketed with non-conducting material to prevent the heat of the outer air from getting to it. At the lower end of each coil is a minute opening, closed by a needle-valve, worked by a screw. Within the tube the pressure is nearly or quite 15 atmospheres; while without it is only one. So that when the valve is opened the compressed air expands enormously and is correspondingly cooled. It may be approximately stated that out of the three-thirds of the air thus compressed, the expansion of two-thirds produces a lowering of the temperature to the point at which the other third of the air liquefies. This liquefied air collects in the lower part of the cylinder jacket; and on opening its tap a stream of liquid air the size of one's finger runs from the apparatus; so that drawing the air from the liquefier is very much like drawing water from a spigot.

This, however, is only the first step in the development of a process which Mr. Tripler hopes to apply for use as a motive power. He is now working this out; and in order to carry his project to a successful and speedy issue, he finds himself reduced to the necessity of using for this purpose all the liquid air that he makes. I wish, therefore, to express my obligations to him for so kindly furnishing the material which I am to have the pleasure of showing you, at the sacrifice of his own work on its use as a motive power. His patents, he tells me, were first taken out in 1891; and he has already succeeded in taking the first step and in producing the liquid air as a result.

The liquid air itself cannot be confined. Even at the critical temperature of —191° C. it is actively boiling under the pressure of one atmosphere. The pressure at —191° C. is therefore only one atmosphere; and this pressure rises steadily as it is heated. Suppose now I heat it up to plus 15°, the ordinary temperature; the pressure would be about 10,000 pounds to the square inch. Inasmuch as one cubic foot of liquid air will make 800 feet of gaseous air, it follows that the condensation is 800 times; and to reduce a gas to $\frac{1}{800}$ of its volume would require a pressure of 800 atmospheres, or 12,000 pounds, to the square inch; that is to say, if it followed Boyle's law, which it does not exactly. Hence it is better not to confine it, but to let it assume its own temperature. It boils at —191° C. at the pressure of the atmosphere or at a higher temperature under an increased pressure. But in the can it is boiling now at the temperature of this room, say 70° F. In boiling it cools itself by evaporation; and, therefore, it becomes cooled finally below the temperature of —191° C. Moreover, the cooler it becomes, the less rapidly it boils. If access of heat be entirely prevented, it will remain quiescent at —191° C.

On removing the lid from the can of liquid air, you observe that a dense mist issues—not New York vapor, but Philadelphia mist. I take this tin dipper and ladle the liquid air out. The temperature of the liquid which is here nearly quiescent in the ladle as I carry it around among you is below —191° C.

If a ladleful be tossed into the air, a large proportion is immediately converted into vapor, producing a mist and creating a sort of comet's-tail along its line of travel; the remainder falling in drops upon the audience and producing, if it touches the skin, a trifling stinging sensation, only momentary in its duration. I recently poured a half dipperful upon a beautiful brocade silk gown to the horror of the wearer, but without harm to the fabric, the liquid air, the instant it touched the garment, being converted into its original gaseous elements. The gaseous air from which the liquid air is made being only ordinary air, cannot possibly injure anything.

The temperature required for liquefaction of air solidifies at the same time the moisture and the 4 per cent. of carbon dioxide always present in the atmosphere; so that if a quantity of liquid air be filtered through ordinary filter paper, we are able to remove these solids and to get a perfectly clear fluid. On pouring some of it into a tumbler at the temperature of the room, you see that it boils furiously, as water would upon a stove, this action being continued until the temperature of the tumbler is cooled down to that of the liquid air within it. You will observe that during this evaporation a layer of ice or snow forms on the outside of the glass, frozen from the moisture of the atmosphere.

So unequal are the temperature strains, external and internal, when using funnels in filtering the liquid air, that, as you see, three out of the four of German make which we have used have broken; while at the Johns Hopkins University the other day, three out of four American funnels broke in the same way. It would be perfectly easy for me to throw this house down with the pressure generated by the evaporation of the liquid air contained in this milk-can. If, for example, I pour a teaspoonful of it into a soda water bottle and cork it, it will blow out the cork with a loud report.

What, then, shall we keep the liquid air in? If placed in a tumbler, you see that it boils and the cold covers the outside of the glass with a layer of moisture and finally frost. The first vessels which were used for the purpose of preserving it were nothing more than such ordinary glass cylinders as are before you, one within another, the interspace containing a drying material (chloride of calcium) to keep the outside of the inside vessel entirely dry; so that when we pour the liquid air into this vessel, there is no moisture deposited and we can see its properties. Without drying the air in this way, moisture will collect on the outside of the containing cylinder at once; and, therefore, the resulting frost will render it opaque.

We are indebted to Prof. Dewar for the devices before you for containing liquid air (now called Dewar globes or bulbs), which, although very simple to look at, are very difficult to make—the Edison Lamp Works, Harrison, N. J., having proved very successful in their manufacture under Mr. Meadowcroft's direction.

These globes are generally double, sometimes triple, one within the other. The interior globe is about 3 inches in diameter; the space between it and the outer globe, or globes, being exhausted of air to such a degree of perfection that there is only about one-millionth of an atmosphere left. Heat, as we know, is transferred through the atmosphere in the first place by convection and conduction—by the transference of air particles carrying the heat with them or by communication through these particles. If I take all these particles out, there will be no such transference. Therefore, if all of the air is exhausted, no heat can be transferred in this way from the air of the room to the inside bulb. In the second place, heat can pass through space by radiation; but by silvering the inside globe upon the exterior, Dewar found that this effect is also prevented; so that the liquid air in one of these globes which is silvered may be made to last ten times as long as in an unsilvered globe.

This clear liquid is only air, composed one-fifth of oxygen and four-fifths of nitrogen. Ozone is condensed oxygen; it contains one-half more oxygen in the same volume than does ordinary oxygen. Ozone, when liquefied, is as blue as indigo; liquid oxygen is as blue as the bluest sky; and one theory of the blueness of the sky assumes that it is due to the oxygen in the air. On mixing four parts of liquid nitrogen, which is absolutely colorless, with one part of the blue liquid oxygen, we get the blueness of the liquid air, as you see it before you.

Heat and cold are relative terms. The other day I froze one of my thumbs with liquid air and cauterized the other thumb with a hot wire; and from the sensation alone, I could hardly distinguish between the two. Just as you may pass the finger rapidly through melted iron or melted lead without being burned, so you can stir with your finger the liquid air at this very low temperature without being injured. This is due in the former case to the fact that the hand is moist. When the hand is placed in the liquid lead the high temperature of the lead converts the water into vapor; so that the hand is surrounded by a layer of non-conducting vapor which protects the hand from direct contact with the hot lead. This layer is called a Crookes layer. In the second case the phenomenon is the same, only reversed; the hand is now the hot substance and the liquid air the cold substance, and there is a greater difference between this low temperature and that of your hand than there is between that of your hand and that of the melted lead. There is formed a cushion of vapor upon the hand; so that, when liquid air is poured upon it, that cushion prevents it from contact, so that it does not burn. If this cushion were not sufficiently non-conducting, however, your hand would be burned very severely.

Air is a mixture—not a chemical combination—of oxygen and nitrogen. Now, as we have seen, liquid oxygen is much heavier than nitrogen—heavier even than water. Moreover, nitrogen boils at —193°, a lower temperature than —180°, that at which oxygen boils; consequently, if I heat liquid air above —191°, the nitrogen will boil off first and a liquid will be left, continually richer in oxygen. Therefore, this faint blue liquid air will become bluer and bluer in proportion as the nitrogen boils off and the oxygen becomes purer and purer. I have here a large globe of water, and you will notice the effect of pouring liquid air upon it; there is produced a torrent of condensed and frozen moisture from the water. Moreover, you observe that the liquid air is at first lighter than the water; but, gradually, as the nitrogen boils off and the oxygen increases, the liquid becomes heavier than the water, and this causes the liquid air to sink down through it in the form of spherules, which finally reach the bottom.

This simple glass globe, into which liquid air was poured and which was suspended here at the beginning of the lecture, has become during the hour heavily coated on the outside, on its lower half, with snow condensed from the atmosphere and frozen there by the intense cold of the liquid air. If a piece of paraffin be immersed in a tumblerful of liquid air at —191° C., it is so much hotter than the liquid air as to make it boil violently—the same effect being produced by the introduction of a piece of resin. The comparative heat in a piece of ice may be shown by immersing it in liquid air, causing the latter to boil, as you see, much as when a red-hot iron is thrown into water.

On removing the paraffin from the liquid air, instead of being semi-transparent, it has become entirely opaque and brittle, while the piece of resin, by an equal immersion, has changed its color and has lost its toughness, so as to fall into pieces when touched. So the frozen water, or ice, which, previous to its immersion in the liquid air, was perfectly clear, has been rendered by still further freezing, not only opaque, but as friable almost as a lump of sand. A piece of beefsteak, when subjected to a bath of liquid air, breaks and is scattered under a blow from the hammer upon an anvil, as you see, like a piece of Tennessee marble.

A strip of sheet tin, when immersed in liquid air, becomes as brittle as glass; whereas a copper strip so treated retains its flexibility. While iron is made thus brittle, its tenacity is greatly increased. Moreover, as Prof. Dewar has shown, the electric conductivity of all metals increases, i. e., the resistance decreases as the temperature falls, so that we have reason to believe that if we can get down to the absolute zero of temperature, a piece of copper wire will oppose no resistance whatever to the passage of the electric current; in other words, we can transmit fifty thousand horse power from Niagara to New York without any loss in the transmission from this cause. These pieces of tin which I have broken off you notice are very coarsely crystalline.

This spiral spring, made of fuse wire (an alloy of tin and lead), which I have cooled in a bath of liquid air, sustains, you see, a kilogramme weight very readily, and is quite elastic. Such an alloy of lead and tin, as you know, is not ordinarily elastic, but when cooled down to this low temperature it becomes so, stretching to thrice its original length in the course of an hour, as it regains the temperature of the air.

I pour some liquid air into a copper tea kettle and replace the lid; the liquid boils actively. I place it upon a gas stove, it boils somewhat faster than before, the vapor coming out of the spout and escaping even under the lid. I pour into it a tumblerful of ice water; the boiling now becomes furious, the jet of vapor issuing to a distance of several feet, and the water being at once frozen, the resulting ice being brittle, just as in the previous experiment. It follows, therefore, that we may make ice in a tea kettle over a fire just as well as we can make tea.

A piece of soft rubber tubing, immersed in liquid air for a moment, becomes hard and extremely brittle. If this small, hollow rubber ball, frozen in the liquid air, be thrown against the wall, with ordinary force, it breaks in pieces. Mercury freezes at 40° below zero and alcohol at —130° C. Hence it is the rarest thing in the world to see alcohol frozen by artificial means. But, in the first place, how do we measure these very low temperatures? I answer, by the very simple process of determining the resistance of a wire, since this resistance diminishes as the temperature decreases. If, therefore, I measure accurately the resistance of a platinum wire and then put it into this liquid air and measure its resistance again, I can determine exactly by how much the temperature is lowered. Thus we can determine temperatures between +1,500° and —240° C. Here is a triangular trough into which I pour mercury; I also pour some into this circular trough, and then I pour liquid air upon both. The air boils actively because the mercury is so much hotter. A looped wire and a solid rod of metal are placed in the respective vessels to serve as handles for the resulting blocks of mercury. One of the blocks of mer-

* Revised by the author. A lecture delivered at the Friends' Institute Lyceum, Philadelphia, by Prof. George F. Barker, of the University of Pennsylvania.

cury thus frozen, you observe, acts under blows from a steel hammer upon an anvil much as lead would. This other hammer-shaped block, made of mercury, has undergone the same change which the tin did a moment ago. When I freeze it a little, it is malleable, but if I freeze it longer, it is brittle, so that when I undertake to drive a nail with it, it goes to pieces. At a recent lecture I succeeded in giving mercury exactly the proper hardness, and then drove a nail into an inch pine board with it. Here is a block of mercury frozen with two screw-eyes in its ends; I am going to cool it still farther in the liquid air to as low a temperature as possible. Frozen as it is, it still has heat enough to make the contents of the can boil. (On removal from the can the block, supported by a horizontal bar of iron, held up a fifty-six pound weight for a space of twenty minutes before the block thawed sufficiently in the air of the lecture room to release the weight.)

Some alcohol which I have treated with liquid air in the tumbler rattles like a piece of ice—being absolutely solid. Until now the most we have been able to do with alcohol is to bring it to a pasty condition.

I now pour liquid air into a large test tube provided with a cork, through which a glass tube passes to the bottom. The heat of the hand generates a pressure which drives the liquid to the ceiling, producing a geyser ten feet or more in height.

As the oxygen remains and the nitrogen boils off, we ought, after reaching a certain stage, to have a large amount of liquid oxygen and practically no liquid nitrogen, the liquid mixture becoming richer in oxygen all the time. Here is a lighted taper, from which I blow the flame, leaving only the glowing end. I introduce it into the highly oxygenated fluid, when it at once bursts into flame. We have here, then, liquid oxygen almost pure. All combustion, as ordinarily witnessed, is an oxygen combustion. Evidently, then, if the oxygen is thus condensed, combustion in it will be greatly intensified. Things ordinarily combustible will burn with increased activity in the condensed or liquefied oxygen.

Here is a steel watch spring—a material not ordinarily considered combustible. I put a match on the end of the spring, light it, and then insert it in the liquid oxygen; you see that it burns brilliantly, the sparks flying off in scintillations as from a hot iron under the blacksmith's hammer. (To a steel pen in a holder a lighted match was similarly attached and the whole was immersed in a tumblerful of liquid oxygen. The pen was quickly burned up, with the most brilliant coruscations.)

If, now, we take a piece of hair felt, which is not combustible in the ordinary sense, merely burning off at the edges when exposed to flame and ceasing to burn when the flame is removed, and soak it in liquid air, and then ignite it, the entire body of the hair felt flashes up and is instantly consumed.

By rubbing this cotton mop, saturated with liquid air, over the outer surface of an exhausted glass sphere containing a globule of mercury, you see that the cold of the liquid air condenses the vapor of mercury present and deposits the metal on the cooled surface of the sphere, thus producing a brilliant mirror.

In the inner space of this double Dewar globe, which I now fill with liquid air, has been placed a globule of mercury. The liquid air in the inner globe will cool the surface of this globe until the vapor of mercury condenses upon it, so that in the course of a short time the surface of this interior globe will become a perfect mirror, thus protecting its contents from radiation.

This scarlet iodide of mercury, subjected to the cold of liquid air, comes out yellow, as you observe, so that the color of substances would be entirely changed if we were living in an atmosphere at the temperature of liquid air.

Here is an electric lantern. I desire, by its means, first to produce an electric beam and then to use this bulb of filtered liquid air as a lens to concentrate the beam and bring it to a focus. Then, placing a piece of thick paper, blackened on one side, in the focus, I burn a hole through it by the heat developed. How does the heat of the sun get to us through celestial space if this space is —273° C., for evidently no heat can get through that? It comes to us in the form of radiation (though it afterward becomes heat on the earth); all heat, even the heat from the sun, we get as radiation—radiant energy. So here I have heat in the arc light—heat which burns a hole in the paper, and yet between the carbons and the paper it traverses a temperature of 191° below zero.

REGULATOR FOR INSTRUMENTS FOR REGISTERING THE DIRECTION OF THE WIND.

THE registering of the motions of the atmosphere is a subject that has long occupied the attention of meteorologists. The idea of inscribing upon paper the variations of a windvane must have quickly occurred to scientists; and, in fact, the idea is a very simple one. The trouble is, however, that the windvane, which, as well known, is a very capricious instrument and obedient to the least veering of the wind, gives in tempestuous weather only exaggerated marks that sometimes cover the inscription of a sudden shifting of the wind, especially if it is feeble and of short duration. It has, therefore, become necessary to seek a method of overcoming this variable behavior of the apparatus by rendering its motions regular and at the same time preserving its sensitiveness.

In order to create the resistance necessary to effect this, recourse has been had either to paddles immersed in a more or less fluid liquid or to complicated systems of fliers, like those of Oesler, Herve Mangon, and Piazzi Smith. In addition to the general drawbacks connected with the use of a liquid, the paddle system presents the very grave inconvenience of rendering erroneous the indications of the registering pen through the reaction upon the paddles of the mass of fluid in motion. The anemoscopes with fliers require on their part most careful surveillance, and at the same time offer considerable resistance when attacked obliquely, and, in a feeble wind, refuse to operate.

M. de Grandmaison has succeeded in overcoming such difficulties to a considerable extent by adapting to the ordinary windvane a moderator formed of a train of clockwork. The annexed figures, borrowed from La Nature, show the principle of the apparatus. The vane communicates its motion to a rod terminating in a cam, *A*, formed of a brass tube lined with lead. Through its pressure upon a roller, *B*, with a horizontal axis, this cam carries along, through the wheels, *C* and *D*, the registering cylinder upon which rests a pen that descends in a helicoidal groove, which it traverses every twenty-four hours. Were the apparatus reduced to these elements, the cylinder would revolve to no purpose at every impulsion of the wind. To prevent this, the wheel, *C*, is connected through a train of toothed wheels with a ratchet that forms part of a clockwork with circular escapement. Such connection is shown in detail in Fig. 2. Whatever be the direction to which the wind has changed, when the click, 1, bears against the ratchet, 2, the teeth of the latter offer to the wind's action a certain amount of resistance, the effect of which is to diminish the registering of sudden veerings of the wind and to leave the cylinder submitted to the action of feeble pressures.

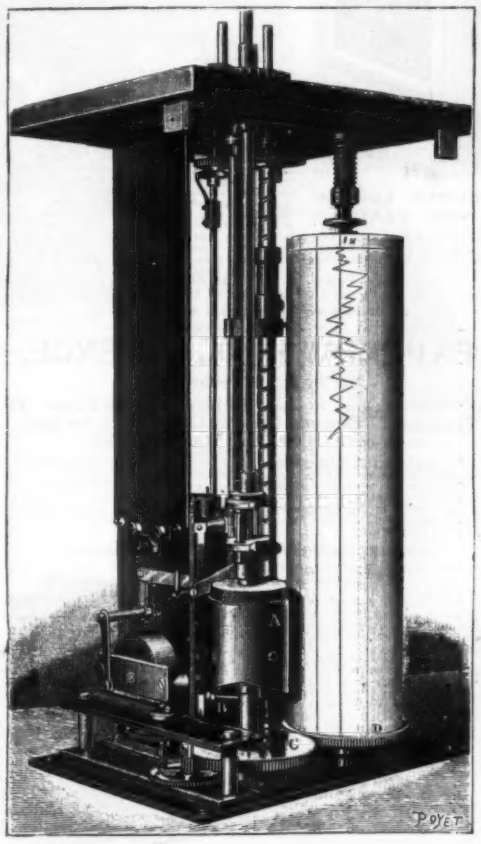


FIG. 1.—REGULATOR FOR REGISTERING THE DIRECTION OF THE WIND.

An inspection of Fig. 2 shows that the action of the wind can in nowise arrest the motion, since, whatever be its change of direction, the rod, 3, always acts, in the direction shown by the arrow, 4, upon the ratchet, the revolution of which takes place in the direction of 5.

Owing to the use of the heart cam as an intermedium for the transmission, it is possible to render the revolution of the cylinder regular. It is possible, likewise, for the operator to effect the regulating in such a way as to vary the velocity of the revolution.

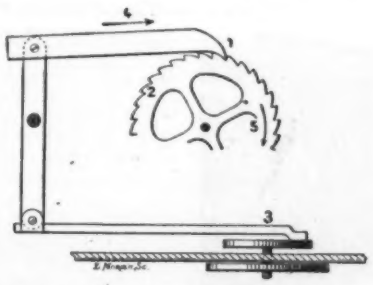


FIG. 2.—DIAGRAM OF THE MODERATING DEVICE.

THE CANNIBAL BLACKS OF NORTHWESTERN AUSTRALIA.

M. LOUIS DE ROUGEMONT, the "Australian Crusoe" whose stories have recently attracted great wonder and some incredulity, recently delivered a lecture before the British Association, at Bristol, England, the subject being his twenty-eight years' sojourn among the cannibal blacks of Northwestern Australia. The following is a synopsis of his paper:

About the year 1863 he joined a pearling expedition, and was wrecked on a small sandspit in the Sea of Timor. Here he spent two and a half years, and only reached the Australian coast through the instrumentality of a party of blacks who had been blown out of their course. Together they reached the mainland of Australia in the Cambridge Gulf region, on the northwest coast of the continent. Here he spent several years, making various excursions, but at length he struck southward into the interior of the continent, where he spent upward of twenty years with the aborigines. Commencing with a description of the painting and decorating of the body, the lecturer said that practically the only clothing known to these savages consisted of a coating of grease, clay, and powdered charcoal, sometimes scented with a kind of pennyroyal herb, and on which feathered tufts were often stuck. He then said that their habitations are not houses in the ordinary sense of the term, but rude huts, oval or round, and merely shelters or breakwinds made of bark or boughs, in front of which a fire was kept burning. On the death of a person his house is burned, so that the dead man's spirit may not be lingering around. These houses are not permanent, for when the occupiers have left, they never return to the same dwellings, but generally leave them to decay. The native crawls into his house through a hole measuring about fifteen inches by ten inches.

These people are—men, women, and children—expert divers and swimmers, as much at home in the water as on land. They chiefly adopt the side stroke, using both hands alternately. Swimming is not taught, but is supposed to be a natural action, the children learning to swim as soon as they can walk. Metals are, for all practical purposes, unknown. Thin flint flakes are made and large stone axes are used for felling trees and cutting wood. The lecturer here remarked that the natives only fell trees with the greatest reluctance, and apologies are offered to the trees for taking away their life. Another consideration, too, in this matter was that the natives fear they may let loose the soul of a low, bad man which has been imprisoned in the tree. Every man makes his own implements and only makes them for himself, although he may barter them away afterward. No articles are ever made with the definite object of barter or disposal in any way. Stone implements are not bequeathed as heirlooms, but generally buried with the owner, so that when his spirit rises again all his weapons will be found ready for use. Fire is produced by the fire drill twirled rapidly between the hands, and also by the stick and groove process. The fuel used is dry dead wood that has fallen from the trees. No trees are felled for firewood under any circumstances. It is the duty of the women to keep the fire alight and generally their duty to do all the work. When a fire goes out the natives believe that it has returned to the sun whence it came.

The people in M. de Rougemont's mountain home were very conservative, having a general attachment to the habits of ancestors and a deep rooted dislike to change and reform. He frequently tested this in matters of state, magic, weapons, war, festivals, and so on. In respect of food, they eat all kinds of wild animals and fruits, suck flowers for honey, eat high meat—practically a necessity, for it is often high on account of the climate before they return from the hunt. A certain kind of manna falls at certain seasons; and milk is unknown. Intoxicating or stimulating drinks are also unknown, but the natives chew and often swallow the leaf of a plant that causes first exhilaration and then oblivion. Great gorging feasts are frequently held. The lecturer said that a very mistaken idea of cannibalism generally prevails. He had never seen any human being eaten for the sake of food. Cannibalism prevailed among his people to a very great extent, but was governed by rules. Usually it is the slain victims in battle that are eaten by the victorious side, and, as the object seems to be to acquire the valor and virtues of the person eaten, M. de Rougemont said he endeavored to wean the tribes in his mountain home from the practice by assuring them that if they made bracelets, anklets, and necklaces out of the dead man's hair they would achieve their end equally well. The natives believe in no deity, but in a supreme spirit, who is not worshiped, but propitiated. The soul is supposed to haunt the habitation after death and to pass into other bodies.

Priests of any kind do not exist, but the medicine man is a power in the land, for he has power to depose even a chief, which he does by sorcery. He is maintained at the expense of that tribe, and the important position passes from father to son. The natives have no heroes. The names of the dead are never mentioned, but referred to in an indirect way. A dead chief might thus be alluded to under cover of the name of his greatest battlefield. Their superstitions are many and varied, and dreams they believe in implicitly. Magic and witchcraft are practiced extensively, both the black and white varieties.

As to crimes, homicide is criminal, except in case of a general battle or a private quarrel, where the dead man was in the wrong. There is never any dissent from the authority of the headmen. There is no criminal class nor any organized system of crime, nor are there any police. There are certain well-known precepts in morals—unwritten laws. These are taught the children by their parents and are upheld by the headmen and council. There is no public opinion, for whatever the headmen decide as correct is obeyed implicitly. Children are never ill-treated or punished. Hospitality is extended toward all men. It is wicked to refuse it and mean to stint it. It is wrong to deceive or steal, except in regard to enemies. Reverence to the aged is an absolute virtue. The land does not belong to the chiefs, but to the tribe as a community. Females and infants cannot hold land under any circumstances. The eldest son has no special privileges, all sons having equal shares. Daughters have no rights whatever from birth to death. Regular courts of justice are held for the trial of offenders. Proved perjury is punishable with death. The chief is not usually appointed, but takes the position by seniority. His power is very great, in fact, absolute. He may declare war or make peace, and decides all important questions by his own vote. He may separate husband and wife, but in such an event he must find the wife a new husband before the decree of divorce can be made absolute.

After briefly describing the methods of hunting and fishing, M. de Rougemont explained the modes and incidents of making and carrying on war. All adult males take part in it from the time when they are 17—that is, after initiation. When they invade an enemy's territory, they make it known to such enemies by remarkable smoke signals. Offensive and defensive alliances are formed with other tribes, but in war tactics

and strategy are alike unknown, as also are night attacks. No battle is ever fought without an open challenge beforehand. Each tribe is nomadic, and for trading purposes or going to fairs it may pass through the territories of other tribes and kill what is required for food. The natives are generally divided into tribes, and these again subdivided into families. An average family may consist of seven persons—one man, two wives, and four children. In an average tribe there will be perhaps twenty or thirty families. These cannibal blacks have a very primitive idea of astronomy, and believe that the earth is flat and the sky supported by poles placed at the edges. The Great Spirit, they say, lives in the Milky Way and never dies. Every moon is supposed to be a fresh one and different from the last. Arithmetic is practically unknown, there being spoken words for numbers only up to four.

Marriage is not regarded as a religious ceremony. A young man avoids his mother-in-law like the plague. He believes that if he even speaks to her his hair will turn gray. In certain rare tribes communal or group marriage prevails. Each man is the husband of all the women and each woman is the wife of all the men. All the wives are of equal rank. Naturally quarrels occur among the women, usually on account of favoritism shown by the husband, or the introduction of a young and relatively beautiful woman. In the event of a quarrel, the two women would retire from the camp armed with a stick or sticks, and they would simply exchange blow for blow on the head without any attempt at parrying—which would be fatal to the woman's life, so great is the contempt the natives have for physical cowardice. It was simply a question of endurance, and when at length one woman is unable to rise from the earth the fight is at an end, and the two combatants dress one another's wounds in the most amicable manner.

The lecturer then discussed the children's games and amusements, tribal marks, and then death and burial. Speaking generally, death from natural causes is unknown, except in the case of very young children. It is brought about by the witchcraft of an enemy, mostly through magic performed by a sorcerer; otherwise they believe they would live forever. The dead body is kept in camp and "waked" for one night, the women moaning and wailing a most plaintive lamentation. Fresh leaves of the man's own "totem" tree are placed in the grave and every detail of burial is in accordance with his "totem" or clan mark. The name of the deceased is never mentioned after his burial, for fear that his spirit should be disturbed. A separate fire is made for the dead man and maintained for weeks and even months. M. de Rougemont, in concluding his address, said the state is landlord, and the people know not rent, rates, or taxes. Every man has a wife—he himself was promptly provided with one—every woman a husband, each child has many fathers and mothers, as he is the child of the tribe. The institution of the workhouse is unknown, as the strong provide for the weak. There are no millionaires and no beggars. No one has more than he wants, and if he had, it would be a trouble to him. Although these people may be considered very low down in the scale of human intelligence, and although they display in many respects the simplicity of children, yet the most civilized nations might learn something from their institutions.

It is curious to note that several members of the British Association seem to be skeptical as to his adventures and asked him various questions and put down the answers for the purpose of verification. Dr. Forbes remarked on the extreme accuracy of the information of other travelers and the remarkable points of coincidences between their accounts and that of M. de Rougemont.

According to La Révue Technique, of Paris, M. C. Márgot, an instructor at the University of Geneva, Switzerland, has made a curious discovery concerning the action of mercury on aluminum. If the surface of a plate of aluminum which has been well sandpapered is rubbed lightly with amalgam of mercury, there will be produced on it, within a very short time, an extraordinary efflorescence. The surface of the metal will be soon covered with a growth of alumina, which will shoot up literally within plain vision. No more remarkable sight is to be observed than the formation of this miniature forest, which attains, in the course of half an hour, a height of nearly one-half inch. If the metal is brushed over it will be found pitted, as if with an acid, at all the parts in which this rapid oxidation has taken place. But a little heat applied to the plate suffices, by reason of the volatilization of the mercury, to arrest the phenomenon entirely. It will, however, be reproduced each time the surface is rubbed anew with a little amalgam of mercury. The experiment succeeds more easily with the amalgam, as it is difficult to sufficiently pulverize a drop of mercury with the finger, the metal not soaking into the aluminum. It is probable that the mercury merely produces catalytic action, and that it then allows the aluminum disintegrated by its presence, or, perhaps, reduced to a porous condition, to be more readily attacked when cold by the oxygen of the air. Nevertheless, the plate is heated to a degree appreciable to the touch, and actual combustion is evidently established.

Experiments with sugar rations for soldiers were tried during the last German maneuvers. Ten men were subjected to the sugar diet, while another ten received exactly the same rations as the rest of the army. The men chosen for the special diet were weak corporeally. According to the official report, the weight of the sugar men increased during the maneuvers more than that of the men on the ordinary ration. "It was proved that during long marches the feelings of hunger could be kept down for a longer time by the use of sugar, that the sugar people suffered less from thirst than the others, and that a few pieces of sugar sufficed to still thirst for a considerable time. It was also observed that symptoms of exhaustion or of sunstroke were quickly overcome by a small ration of sugar." The authorities now recommend that sugar be considered a regular article of soldiers' food, and that, above all, soldiers on the march should have a supply of it.

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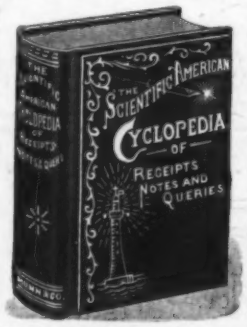

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TABLE OF CONTENTS.

PAGE

I. ANTHROPOLOGY.—The Cannibal Blacks of Northwestern Australia 19037

II. ARCHÆOLOGY.—Recent Study of Prehistoric Man in Europe.—1 illustration 19035
The Fire Department of the City of Rome.—4 illustrations 19035

III. ASTRONOMY.—The Development of Photography in Astronomy 19033

IV. BIOGRAPHY.—Wilhelmina, Queen of the Netherlands.—1 illustration 19024

V. BOTANY AND HORTICULTURE.—Buddleia Variabilis.—1 illustration 19034
Horseradish 19034

VI. CIVIL ENGINEERING.—Object Lesson Roads.—3 illustrations. 19026

VII. COOKERY.—Fruit Preserving.—By Mrs. HENRY ESMOND 19025

VIII. ECONOMICS.—World's Savings Banks 19024

IX. ELECTRICITY.—An Electric Fire Extinguisher.—1 illustration. 19025
Ships' Cranes 19030

X. EXPLOSIVES.—High Explosives and Smokeless Powders and their Applications in Warfare.—By HUDSON MAXIM 19029

XI. MARINE ENGINEERING.—Machine for Propelling a Boat by Means of Paddles with Considerable Speed and Without Employing Many Men.—2 illustrations 19027

XII. MECHANICS.—A New Mechanical Motion.—1 illustration 19037
Regulator for Instruments for Registering the Direction of the Wind.—2 illustrations 19037

XIII. MEDICINE.—Typhoid Fever in Porto Rico 19032

XIV. MISCELLANEOUS:
Engineering Notes 19028
Miscellaneous Notes 19028
Selected Formulæ 19028
Waxen Images 19025

XV. NATURAL HISTORY.—Experiments on Animal Intelligence.. 19031
Wart Hog Surprised by a Leopard.—1 illustration 19031

XVI. PHOTOGRAPHY.—Some New Hand Cameras.—9 illustrations 19030
The Development of Photography in Astronomy 19033

XVII. PHYSICS.—Liquid Air.—By Prof. G. F. BARKER 19026

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